BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE OCCUPATIONAL SAFETY AND HEALTH STANDARD 91-12

1 SEPTEMBER 1998

Safety

MACHINERY

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Supersedes AFOSH Standard 127-12,
29 March 1991

Pages: 71
Distribution: F

The criteria in this standard are the Air Force's minimum safety, fire prevention, and occupational health requirements. Major commands (MAJCOM), direct reporting units (DRU), or field operating agencies (FOA) may supplement this standard when additional or more stringent safety and health criteria are required. Refer to Air Force Instruction (AFI) 91-301, *Air Force Occupational and Environmental Safety, Fire Protection, and Health (AFOSH) Program*, for instructions on processing supplements or variances. Report conflicts in guidance between this standard, federal standards, or other Air Force directives through MAJCOM, DRU, or FOA ground safety offices to Headquarters Air Force Safety Center, Ground Safety Division, Safety and Engineering Standards Branch, (HQ AFSC/SEGS), 9700 G Avenue, SE, Suite 222, Kirtland AFB, NM 87117-5670.

This standard applies to all United States (US) Air Force organizations, including all US Air Force Reserve personnel and when Air National Guard personnel are on federal service. Sources of additional or more specific guidance are shown in parenthesis throughout the standard. Refer to Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910 Subpart O, *Machinery and Machine Guarding,* and the National Safety Council (NSC) *Accident Prevention Manual for Industrial Operations,* for additional definitions and illustrations.

No Technical Order (TO), AFOSH Standard, or Operating Instruction can possibly address every hazard or potential hazard that may arise from a specific task or combination of tasks. Where situations exist that do not appear to be adequately covered by existing directives, use an Operational Risk Management (ORM) process to assess risk associated with those situations and determine adequate safeguards or procedures to manage the risk. **NOTE:** The ORM process may not be used to violate directives or other regulatory guidance. Normal waiver or variance procedures must be followed in all cases (refer to the first paragraph on page 1).

SUMMARY OF REVISIONS

Administrative changes have been made to update this standard to electronic format. Paragraphs have been renumbered and references updated. Requirement to use ORM process is addressed in third paragraph, page 1. References to "Morale, Welfare, and Recreation (MWR)" have been changed to "Ser-

vices" (paragraphs 1.2.3.3., 1.2.3.4., 1.2.5.6., and 2.2.1.9.1). A glossary of references and supporting information is provided at **Attachment 1**. A bar (|) preceding a paragraph indicates changes from the previous edition. **Note**: AFOSH 127-series standards are being converted to 91-series standards and 161-series to 48-series standards. However, not all standards have been converted as of the effective date of this standard. To help you locate these documents, references to AFOSH standards are stated in the updated series and standard number, with the outgoing series and standard number stated as "formerly designated as" in the references section of **Attachment 1**.

Chapter 1

GENERAL

1.1. Hazards and Human Factors:

1.1.1. All mechanical motion is potentially hazardous. Motion hazards, such as rotating devices, cutting or shearing blades, in-running nip points, reciprocating parts, linear moving belts and pulleys, meshing gears, and uncontrolled movement of failing parts, are examples of motion which may be peculiar to any one machine or job operation. Personnel working within areas where they are exposed to machinery or equipment hazards must be aware of the potential for mishaps.

1.1.2. Machine operators and others are exposed to moving parts and can get clothing, hair, or body parts caught in the machinery. The chance of these mishaps occurring is greater as fatigue increases or as attention decreases. Pressure to get the job done may result in either overlooking sound work practices or attempting to bypass guards. This is particularly true when the operation necessitates the removal of guards to make adjustments, etc.

1.1.3. The techniques and skills required for setting up and operating equipment demand effective training programs.

1.1.4. Managers, supervisors, and workers must be aware of human factors such as fatigue, worry, anger, inattention, illness, or improper attitudes that may lead to errors and resultant injuries. Engineers, functional managers, and supervisors must consider personnel exposure and work processes when placing machinery and equipment in the workplace.

1.2. Requirements:

1.2.1. Acquisition. Machines and attachments may be both locally and centrally procured. All newly acquired machines will meet the design and construction requirements identified in Military Specifications (Mil Spec). OSHA standards identified in **Table 1.1.** will be used when no Mil Specs exist. Supervisors needing access to OSHA standards should contact the installation ground safety office. If a machine is not specifically covered by this standard, a Mil Spec, or an OSHA standard, the installation ground safety staff shall be contacted for assistance in identifying applicable criteria.

1.2.2. Installation*:*

1.2.2.1. Machines designed for fixed locations or that may tip over will be securely fastened to the floor or other suitable foundation to eliminate all movement or *walking*. Machines equipped with rubber feet, nonskid foot pads, or similar vibration dampening materials will be installed according to the manufacturer's recommendations. Weight limitation of floors or foundations will be considered prior to machinery installation. (29 CFR 1910.212(b), *General Requirements for all Machines*)

Table 1.1. OSHA Standards.

Subject	OSHA Standard
The Control of Hazardous Energy (Lockout/Tagout)	29 CFR 1910.147

Machinery and Machine Guarding	29 CFR 1910 Subpart O
Definitions	29 CFR 1910.211
General Requirements for all Machines	29 CFR 1910. 212
Woodworking Machinery Requirements	29 CFR 1910.213
Abrasive Wheel Machinery	29 CFR 1910.215
Mechanical Power Presses	29 CFR 1910.217
Mechanical Power Transmission Apparatus	29 CFR 1910.219

1.2.2.2. Sufficient space will be provided around each machine so materials can be handled with the least possible interference from and to other workers and to allow access for maintenance and repair. (For detailed information on shop layout, passageways, and machine clear zones, refer to AFOSH Standard 91-22, *Walking Surfaces, Guarding Floor and Wall Openings and Holes, Fixed Industrial Stairs, and Portable and Fixed Ladders.*)

1.2.2.3. The installation bioenvironmental engineering (BE) personnel will determine the requirements for exhaust systems. Normally, machines that develop fine dust and fumes that are hazardous to workers should be equipped with effective hoods, connected to an exhaust system. An interlocking device should be installed to link the machine's power supply and the exhaust system to prevent the operation of the machine without the exhaust system operating. In shops where small numbers of installed machines are not continuously in operation, portable collection systems may be more cost effective. Hoods and exhaust systems will be constructed and installed to meet requirements in AFOSH Standard 48-2, *Industrial Ventilation*.

1.2.2.4. The installation BE personnel will determine the requirements for lighting. At least 50 foot-candles of illumination will be maintained at the machine operator's position. Fine work may require 100 or more foot-candles. This can be obtained with a combination of increased general lighting plus supplementary lighting. If fluorescent lighting is used, it will be installed to eliminate any stroboscopic effect with moving machinery.

1.2.2.5. Machine energy isolating devices will be capable of being locked out by a designed hasp or other attachment or an integral part to which, or through which, a lock can be affixed or the energy isolated by simply disconnecting an electrical plug.

1.2.3. Training. Personnel shall be trained by the supervisor or a designated trainer on all machinery or equipment they are required to use. Only trained personnel or those undergoing supervised on-the-job training will operate shop machinery or equipment.

1.2.3.1. Operators will be trained in the proper operation, safety procedures, hazard recognition, and emergency shutdown procedures for each machine or piece of equipment they are to use.

1.2.3.2. Operators will also be trained on machine or equipment maintenance they are allowed to perform.

1.2.3.3. Services craft or hobby shop patrons will be trained by the supervisor or a designated trainer on the proper operation, safety procedures, hazard recognition, and emergency procedures for each piece of equipment they will use. An AF Form 1451***, AF Arts and Crafts Equipment Qualification***, will be issued to identify the machinery the patron is authorized to operate. Personnel will not operate machines or equipment if this card is not available.

1.2.3.4. Supervisors and operators will receive training on lockout and tagout procedures contained in AFOSH Standard 91-45, *Hazardous Energy Control and Mishap Prevention Signs and Tags*, to ensure the purpose of the program is understood, and that each has the knowledge and skills required to apply and remove locks and tags. Operators will be retrained when there is a change in energy control procedures or a change in job assignment, machines, or equipment. Services patrons will be trained to understand the lockout and tagout program but will not apply or remove locks or tags.

1.2.4. Safe Operations:

1.2.4.1. Machines will be used only for work within the rated capacity specified by the machine manufacturer.

1.2.4.2. Machines will be maintained so, while running, they are free of excessive vibration. (29 CFR 1910.213(a)(1), *Woodworking Machinery Requirements*)

1.2.4.3. Machines will be completely stopped before attempting to clear jammed work or debris.

1.2.4.4. No blade, cutterhead, or collar will be placed or mounted on a machine arbor unless it has been accurately sized and shaped to fit the arbor. (29 CFR 1910.213(a)(14))

1.2.4.5. Arbors and mandrels will have a firm and secure bearing and be free from excessive end play. (29 CFR 1910.213(a)(2))

1.2.4.6. Machines will never be left unattended with the control switch in the **ON** position. If a power failure occurs, the operator will immediately switch the machine to the **OFF** position.

1.2.4.7. Supervisors will ensure only authorized personnel operate and maintain shop equipment.

1.2.4.8. Personnel who are operating, helping, or observing machine operations shall comply with the personal protective equipment (PPE) requirements for the area and particular machine. (Refer to AFOSH Standard 91-31, *Personal Protective Equipment*, for PPE types and selection information.)

1.2.4.9. Loose fitting clothing, neckties, rings, bracelets, or other apparel that may become entangled in moving machinery, power transmission apparatus, or moving parts will not be worn by machine operators, their helpers, or anyone in close proximity of this equipment.

1.2.4.10. Hair nets or caps shall be worn to keep long hair under control and safely away from moving machinery, power-transmission apparatus, or moving parts.

1.2.4.11. The operator will allow all moving parts to come to a complete stop before any attempt is made to clean any part of a machine. Chips or other particles will be removed by brushes or compressed air. If compressed air is used, the nozzle pressure at the discharge end of the air line will be as low as practical, but will not exceed 30 pounds per square inch (psi). Compressed air will not be used to blow chips or other debris from a worker's body or clothing. To prevent flying chips and particles from striking the eyes and skin of the operator and bystanders, screens, barriers, or protective cones attached to air nozzles will be used.

1.2.5. Inspection and Maintenance:

1.2.5.1. Supervisors shall ensure all machines are inspected upon receipt to detect and correct defects. Technical Order (TO) 34-1-3, *Inspection and Maintenance of Machinery and Shop Equipment*, will be followed for periodic inspection requirements.

1.2.5.2. Operator's inspection shall be conducted prior to the start of each shift, following a new setup, or when operators change. This inspection will ensure operating components are in good working order and guards, interlocks, and other protective devices are securely mounted, operating properly, and in proper adjustment. Necessary maintenance or repair will be performed and completed before the machine is placed in operation.

1.2.5.3. Repairs that are beyond the operator's capability will only be accomplished by a qualified technician.

1.2.5.4. When maintenance is needed, whether it is done by the supervisor, operator, or a specialized technician, machines will be completely shut down and all energy isolating devices locked out in the **OFF** position. The appropriate warning tag will be affixed to the machine and (or) energy source. In cases where machine or equipment design prohibits the lockout capability, the tagout procedure with the AF Form 982, ***Do Not Start*** tag shall be used. When these machines and equipment are overhauled or replaced, energy isolating devices or controls that can be locked out must be installed. (See AFOSH Standard 91-45 for specific guidance on installation of locks and tags.)

1.2.5.5. All guards, interlocks, and safety devices shall be in place prior to restoring power, unless their removal is required by technical data for an operational check.

1.2.5.6. Services patrons will not perform maintenance on shop equipment. Malfunctioning equipment will be shut down immediately and reported to the supervisor.

Chapter 2

WOODWORKING MACHINERY

2.1. Hazards and Human Factors:

2.1.1. Hazards. The primary hazard of woodworking equipment is high-speed, revolving cutting blades and knives. Contact with these parts can result in lacerations and amputation of body parts. Other job hazards that account for a wide variety of injuries and illnesses are:

2.1.1.1. Jamming or kicking back of material and wood chips;

2.1.1.2. Flying objects (wood chips, broken saw blades, etc.);

2.1.1.3. Poor housekeeping;

2.1.1.4. Improper material handling;

2.1.1.5. Unsatisfactory maintenance of machinery;

2.1.1.6. Excessive equipment noise; and

2.1.1.7. Inhalation of wood dust.

2.1.2. Human Factors. Many of the injuries that occur in woodworking jobs result from personnel failing to follow prescribed safe operating practices. These failures result from worker attitude, inadequate training, and supervisory failure to enforce safe job procedures. The use of machine guards, environmental controls, good training, and maintenance programs, coupled with supervisory enforcement of protective equipment use and safe job practices, can eliminate most mishap-producing factors.

2.2. Requirements:

2.2.1. Tilting-Arbor and Tilting-Table Saws: (29 CFR 1910.213(c), (d), and (e))

2.2.1.1. Table saws will be equipped with a hood that covers the blade and automatically adjusts itself to the thickness of the material upon which it rides. The hood will cover the part of the saw blade exposed above the material and will be adaptable to cover tilted blades.

2.2.1.2. Table saws will be provided with a spreader to prevent the wood's internal stresses from clamping down on the saw blade.

2.2.1.3. Table throat openings will be kept as small as possible to prevent material from dropping below the level of the table. Several size throat pieces will be available to accommodate rabbeting, grooving, and dadoing operations.

2.2.1.4. Devices such as antikickback dogs and fingers or safety hold-down wheels will be installed when ripping material. Antikickback dogs and fingers will be inspected before each use and be kept sharp to maintain their holding power.

2.2.1.5. Saw operators will not reach over a revolving saw blade for any reason. If this appears necessary, a helper will be positioned at the output end of the saw.

2.2.1.6. Saw blades will not be stopped after the power is off by thrusting a piece of wood against the cutting edge or side of the blade.

2.2.1.7. Saw tables should extend far enough on either side of a machine to give full support to any length of board that may be cut.

2.2.1.8. The blade or cutting head will be inspected to see that it is in proper cutting condition, for example, teeth sharp and properly set, no cracks, and free of foreign residue, before starting any job.

2.2.1.9. The correct blade will be matched to the work being done, which will aid in avoiding kickbacks and other hazards. The following precautions will be taken:

2.2.1.9.1. A crosscut blade will not be used for rip sawing or a ripping blade for crosscutting. Use of the wrong blade requires additional force to feed material and increases the danger of a slip-of-the-hand mishap, as well as encouraging a kickback. Services hobby shop supervisors will clearly label each saw with a sign or decal, stating which type blade is installed and its uses.

2.2.1.9.2. Special blades should be used for such materials as plywood or lumber in which there might be nails or other metal. If warped, twisted-grain, knotty, or frozen lumber must be ripped, a carbide-tipped, controlled-cut blade will be used.

2.2.1.10. Operators will not crowd the saw, that is, force the material faster than it can be easily cut. If the saw does not cut a clean, straight line, something is wrong with the saw or the running speed. These conditions are potential sources of mishaps and will be checked and remedied.

2.2.1.11. The rip fence will be adjusted only when the saw is turned off and the blade rotation has stopped. To enable the operator to set the rip fence without lifting the saw guard, a permanent line should be marked on the table in front of and in line with the saw blade.

2.2.1.12. Hands will be kept out of the line of cut when feeding saws. When there is not enough room for hand movement between the rip fence and saw blade, material will be moved forward with a push stick.

2.2.1.13. The hood will not be removed when narrow material is being ripped. Clearance for the hood can be obtained by attaching a filler piece to the table between the rip fence and the saw blade.

2.2.1.14. Saw blades will be set no higher than is necessary to cut through the material being worked. One of two acceptable practices will be used: either no more than three teeth will protrude above the material being cut, or not more than one-eighth of an inch of saw blade will protrude above the material being cut.

2.2.1.15. Feather boards will be used as side guides and top holddowns on operations, such as rabbeting, grooving, and dadoing, when a blade hood cannot be used. Their comb-tooth or feathered edges are suitable to provide the right kind of pressure to firmly guide the material and prevent it from kicking back. Also, they prevent the operator's hand from moving into the blade.

2.2.2. Radial Arm Saws: (29 CFR 1910.213(h))

2.2.2.1. Radial saws will be equipped with a hood that encloses the saw blade and the arbor ends. The lower section of the hood will be hinged so it rises and falls, adjusting itself automatically to the thickness of the material as the saw passes through it.

2.2.2.2. An antikickback device or hold-down wheel will be installed on saws used for ripping. The device will be adaptable to any thickness of stock to be cut.

2.2.2.3. Manually-operated radial saws will be installed so the front of the table is slightly higher than the rear, which should prevent the cutting head from moving forward when the motor is turned on (without touching the moveable saw head). If the saw cutting head moves forward, the operator should first check to make sure the saw blade is not touching the table top. If the saw blade is located correctly, the front of the table should be raised a little higher.

2.2.2.4. With the saw turned off, the operator should pull the saw cutting head all the way forward and with the operator's hand on the pull grip and exerting minimal or no force, follow the head back to its original noncutting position. If the movement of the saw has a tendency to drag, is jerky, or requires excessive force, the operator will check the rollers for wear.

2.2.2.5. The operator should turn the saw ON and observe that the saw cutting head does not move forward.

2.2.2.6. If a sluggish or hesitant movement of the saw is detected during operation, the unit will be turned off and taken out of service until the cause of the malfunction is corrected.

2.2.2.7. If at any time the saw rolls or moves out on the arm away from the column unassisted as a result of vibration, the unit will be taken out of service until the cause of the malfunction is corrected.

2.2.2.8. The saw will have a positive limit-stop to prevent the saw from traveling beyond the front edge of the table. Since this limits the width of the material that can be cut, it may be necessary to increase the width of the table so the saw can be operated safely the full distance of the arm.

2.2.2.9. When the saw is being used to crosscut a board, the operator will pull the saw cutting head forward by hand until the cut is completed, then push the cutting head back easily to its noncutting position. At no time will the operator release the cutting head and let it roll back to the noncutting position by itself.

2.2.2.10. Material will be measured by placing the material to be cut against a stop gauge (whenever repeat cuts are required). When it is necessary to measure with a ruler, material will be kept well away from the saw until measuring is completed.

2.2.2.11. When ripping with a radial saw is necessary, the saw head will be rotated 90 degrees right or left, and clamped in position. The material will then be fed against the revolving blade from the side where the blade rotates upward toward the operator. The teeth of the saw will extend slightly through the material being cut. Failure to observe this precaution gives the saw teeth a strong tendency to pick up the material and throw it forcibly in the direction of the operator. The direction of the saw rotation will be conspicuously marked on the hood. In addition, a permanent decal or sign not less than 1 inch by three-fourths of an inch will be affixed to the rear of the guard at approximately the level of the arbor, reading "**CAUTION: NEVER RIP FROM THIS END**" or the nearest commercially available equivalent.

2.2.2.12. Stock will not be removed from the table until the saw is returned to its stopped position.

2.2.2.13. When making angle cuts or miter cuts, the locking device on the saw head will be securely fastened.

2.2.2.14. When crosscutting, the stock will lie solidly on the table and against the back guide.

2.2.2.15. Care will be taken to ensure the blade being used is proper for the work being performed.

2.2.2.16. When removing short pieces from a table close to the saw blade, the operator will ease the saw back to the idling position and make sure all bouncing has stopped before placing hands on the table. Cylindrical stock will be cut on a radial saw only when it is securely clamped.

2.2.3. Band Saws: (29 CFR 1910.213(i))

2.2.3.1. Both upper and lower wheels will be completely enclosed on both sides. The enclosures should be capable of being removed easily to permit saw blade maintenance.

2.2.3.2. The working part of a saw blade, between the guide rolls and the upper wheel enclosure, will be guarded to prevent accidental contact with the saw blade. The guard will be self-adjusting and attached to the gauge so that, in any position of the gauge, the guard will completely cover the portion of the saw blade between the guide rolls and the upper wheel enclosure.

2.2.3.3. Saws should be equipped with an automatic tension control to compensate for the contraction that takes place in the cooling of the blade after a job is finished and to ensure proper tension of the saw blade.

2.2.3.4. Feed rolls on self-fed handsaws will be guarded to prevent the operator's hands from coming into contact with the in-running rolls at any point.

2.2.3.5. The saw speed will not exceed the safe limit recommended by the manufacturer.

2.2.3.6. If material binds or pinches on the blade, the operator will not attempt to back the work away from the blade until the machine is turned off and blade motion has stopped.

2.2.3.7. If a saw blade should break, the operator will shut off the power, lock the start switch in the OFF position, and not attempt to remove any part of the saw blade until the machine has completely stopped.

2.2.4. Jointers: (29 CFR 1910.213(j))

2.2.4.1. Each hand-fed planer and jointer with a horizontal or vertical head will be equipped with a cylindrical cutting head, the knife projection of which will not exceed one-eighth of an inch beyond the cylindrical body of the head.

2.2.4.2. The opening in the table will be kept as small as possible. The clearance between the edge of the rear table and the cutting head circle or knives will not be more than one-eighth of an inch. The table throat opening will not be more than 2 inches when tables are set or aligned with each other for a zero cut.

2.2.4.3. Jointers with front-table-mounted fences will be equipped with an adjustable device to prevent thin stock from slipping laterally under the portion of the fence at the rear of the table.

2.2.4.4. An automatic guard will be provided to cover the section of the cutter head near the operator (on the working side of the fence) and to contact the wood to prevent any opening from remaining between the guard and wood during the operation. The guard will cover the section of the cutter head on the nonworking side of the fence, especially when the fence is moved toward the automatic guard. There are two types of automatic guards commonly found on jointers. One type is pushed aside by the material and is referred to as a swing guard. The other type found on some old machines rises to the top of the stock and drops after the material passes beneath it. Each

type has some advantages and disadvantages depending on the principal type of operation performed. The swing guard is the most common type. The swing guard is pushed aside by the stock passing over the cutting head and is returned against the fence by a spring after the wood is removed. For surface jointing, the cutter head will be momentarily exposed as the rear of the stock passes over it. A well-constructed push block will protect an operator's hand at this point. The overhead guard may rise above the material or in some designs will also move to the side of the stock. This guard does impede the use of push blocks.

2.2.4.5. The guard over the section of the cutting head on the rear side of the fence will consist of a sliding metal shield that will automatically adjust to the exposed length of the cutter head.

2.2.4.6. Whenever power feeders are used, the feeding mechanism will be guarded by a metal shield or hood.

2.2.4.7. Because the knife blades on a revolving cutting head produce a thrust forceful enough to pull the stock from an operator's hand, holddown push blocks, jigs, or fixtures will be used.

2.2.5. Power Feed Planers: (29 CFR 1910.213(n))

2.2.5.1. Guards will be provided for feed rolls, cutting heads, and holddown rolls at the discharge end. Feed rolls will be guarded by a metal strip in front of the rolls under which the material may pass, but which will prevent an operator's fingers from being drawn into the rolls while feeding the machine. Where the top roll is corrugated, the strip should extend over the top of the roll. Cutting heads and discharge rolls will be guarded by a solid metal enclosure of substantial construction. The hood of an exhaust system may form part or all of the enclosure.

2.2.5.2. When other than corrugated top-feed rolls are used, an antikickback device will be installed.

2.2.5.3. The operator will examine each planer before using it to ensure that knives are not set to take too heavy a cut for one pass.

2.2.5.4. Helpers will position themselves where they will not be pinned between the material and an immovable object.

2.2.5.5. Operators will be especially careful of their fingers when surfacing a short length of material as the infeed rolls may tip the material up and then down quickly, causing fingers to become pinched between the table top and the material.

2.2.6. Shapers: (29 CFR 1910.213(m))

2.2.6.1. Shapers will be equipped with a braking device that will bring the cutting head to a stop within 10 seconds after power is shut off. A double-spindle machine will be equipped with separate braking devices.

2.2.6.2. A fence will have as small an opening for the knives as possible and will extend at least 18 inches on either side of the spindle.

2.2.6.3. Cutting heads will be enclosed by a guard. The guard will not be less than the greatest diameter of the cutter. Attachments of a warning device of leather or other such material to the spindle are not acceptable.

2.2.6.4. Whenever possible, holddowns and jigs will be used to limit exposure of hands to cutters.

2.2.6.5. When a blade is removed from a spindle for sharpening, or for some other purpose, all other blades will be removed at the same time.

2.2.7. Lathes: (29 CFR 1910.213(o))

2.2.7.1. Rotating, cutter-type lathes will be provided with a hinged metal shield or hood that completely covers the knives and material when the machine is in operation. Exhaust system hoods may be included as part of the guard if they comply with standard guard designs.

2.2.7.2. Automatic lathes will be equipped with a brake that will bring the rotating material to a quick, but not instantaneous, stop after the power is shut off.

2.2.7.3. Automatic lathes will be placed with the back side against a wall or barrier to contain knives should they be thrown rearwards.

2.2.7.4. Tool rests will be set parallel and as close as possible to the work and high enough so the tools will butt into the wood slightly above the horizontal center of the piece being turned.

2.2.7.5. Faceplate type lathes will be provided with a control stop so the operator cannot unintentionally throw the power directly from the normal running direction of rotation into reverse. This will avoid the possibility of the faceplate unscrewing and flying off.

2.2.7.6. Lathes used for turning long pieces of material will be equipped with guards that will contain the workpiece if it separates from its anchorage.

2.2.7.7. Operators will not stand directly in line with hand-turning tools.

2.2.7.8. When sanding, the sandpaper will be held in the fingers and pressed lightly against a small area at the top of the rotating material. This will keep the sandpaper from catching and pulling the operator's hand around the material.

2.2.7.9. Poor quality wood will not be used for wood turning.

2.2.8. Sanding Machines: (29 CFR 1910.213(p))

2.2.8.1. Feed rolls of self-feed sanding machines will be protected with a guard to prevent hands from coming in contact with the in-running rolls at any point.

2.2.8.2. Belt sanding machines will be provided with guards at each nip point. These guards will effectively prevent hands or fingers from coming in contact with the nip points. The unused run of the sanding belt will be guarded against accidental contact.

2.2.9. Boring and Mortising Machines: (29 CFR 1910.213(l))

2.2.9.1. Safety-bit chucks will not have projecting set screws.

2.2.9.2. A guard will be provided which will enclose all portions of the bit chuck above the material being worked.

2.2.9.3. The top of the driving mechanism will be enclosed.

2.2.9.4. If there is a counterweight, one of the following (or equivalent) methods will be used to prevent its dropping:

2.2.9.4.1. It will be bolted to the bar by a bolt passing through both the bar and counterweight.

2.2.9.4.2. A bolt will be put through the extreme end of the bar.

2.2.9.4.3. Where the counterweight does not encircle the bar, a safety chain will be attached to it.

2.2.9.4.4. Other types of counterweights will be suspended by chain or wire rope and will travel in a pipe or other suitable enclosure wherever they might fall and cause injury or damage.

2.2.9.5. Universal joints on spindles of boring machines will be completely enclosed to prevent accidental contact by the operator.

2.2.9.6. Each table-type boring or mortising machine will be equipped with holddown devices to keep work securely in place.

2.2.10. Tenoning Machines: (29 CFR 1910.213(k))

2.2.10.1. Feed chains and sprockets of double-end tenoning machines will be completely enclosed, except for that portion of cabin used for conveying the stock.

2.2.10.2. Sprockets and chains will be guarded at the sides by plates projecting beyond the periphery of sprockets and the ends of lugs at the rear ends of frames over which feed conveyors run.

2.2.10.3. Each tenoning machine will have cutting heads and saws, if used, covered by metal guards. These guards will cover at least the unused part of the periphery of the cutting head. Where an exhaust system is used, the guard may form part or all of the exhaust hood.

2.2.11. Electrical Requirements and Safeguards: (29 CFR 1910.213(b) and 1910.147, *The Control of Hazardous Energy (Lockout/Tagout)*)

2.2.11.1. The motor **START** switch will be protected against accidental or inadvertent operation. (29 CFR 1910.217(b)(8)(ii), *Mechanical Power Press*)

2.2.11.2. All machinery will be installed according to the National Electrical Code (NEC).

2.2.11.3. Control switches will be available to workers at their operating positions so they will not need to reach over moving parts of machinery. The stop control switch will be identified by a printed word or color coded red. Controls will not be wedged for continuous operation.

2.2.11.4. Machines, which are not adequately safeguarded to protect the worker during an undervoltage situation or a power failure, shall have an undervoltage protective device installed. This device prevents the machine from starting up after a power interruption and in some cases exposing the worker to the hazards of moving parts. Qualified operators following the safe operating practice in paragraph **1.2.4.** will make the installation of the undervoltage protective device unnecessary in many cases. The installation ground safety officials and work center supervisors are responsible for identifying those machines that require this protection. (29 CFR 1910.213(b)(3))

2.2.11.5. Foot treadle controls shall be protected against unexpected or accidental tripping. These controls shall also have a nonslip surface.

2.2.11.6. Exposed noncurrent-carrying metal components that may become energized shall be grounded.

2.2.11.7. Before performing maintenance or major adjustments to moving parts that require panels and guards be removed, all machine energy sources or energy isolating devices shall be locked out and (or) tagged out. AF Form 982 may be used temporarily until the lockout is accomplished

or in conjunction with the lockout (see AFOSH Standard 91-45). A machine or other equipment with a simple wall plug as the power source will be unplugged and controlled by the supervisor or operator.

2.2.12. Safeguarding by Location or Distance. To safeguard by location, the machine or its dangerous moving parts must be positioned so hazardous areas are not accessible or do not present a hazard to a worker during the normal operation of the machine. This may be accomplished by locating a machine where a building design feature, such as a wall, protects the worker and other personnel. Additionally, enclosure walls or fences can restrict access to machines. Another possible solution is to have dangerous parts located high enough to be out of the normal reach of any worker. Before attempting the use of these safeguarding techniques, a thorough hazard analysis of each machine and particular situation is absolutely essential. The supervisor and installation ground safety personnel shall perform this analysis and publish the results. The analysis must clearly identify that workers are protected from dangerous moving parts and one of the restrictions in paragraphs **2.2.12.1.** and **2.2.12.** is met.

2.2.12.1. Moving parts of machines shall be a minimum distance of 8 feet above the work level, e.g., floor, platform, or passageway.

2.2.12.2. Machines shall be in an enclosed area with a locked entrance. The enclosure (wall or fence) shall be at least 8-feet high. The main source of power shall be disconnected and locked in the **OFF** position when maintenance, service, or major adjustments are made to moving parts with guards and panels removed. The AF Form 982 should be used in conjunction with the lockout, or in place of the lock if lockout is not possible.

2.2.13. Safeguarding Devices. A safeguarding device that performs one of several functions can be used to replace a guard. It must:

2.2.13.1. Stop the machine if a body part is inadvertently placed in the danger area;

2.2.13.2. Restrain or withdraw the operator's hands from the danger area during operation;

2.2.13.3. Require the operator to use both hands on machine controls, thus keeping both hands and body out of danger; or

2.2.13.4. Provide a barrier that is synchronized with the operating cycle of the machine in order to prevent entry to the danger area during a hazardous part of the cycle.

2.2.13.4.1. These devices shall be installed, adjusted, and used according to manufacturer's operating and maintenance instructions.

2.2.13.4.2. All hazardous parts not protected by the device must be guarded according to paragraph **2.2.14.**

2.2.14. Safeguarding by Barrier or Enclosure. These guarding techniques primarily apply to three areas: power transmission apparatus, feeding and ejection areas, and points of operation. Barriers may be fixed, adjustable, or self-adjusting. Enclosure guards are normally fixed. Both types can be equipped with an interlock that prevents the machine from cycling or starting if the guard is opened or removed. Because the type of operation, size or shape of material, and method of handling vary between machines, the type of barrier or enclosure selected will also vary.

2.2.14.1. Every guard must, by design, construction, application, and adjustment:

2.2.14.1.1. Prevent hands, fingers, or other body parts from entering into the hazardous areas by reaching through, over, under, or around the guard;

2.2.14.1.2. Create no pinch point between the guard and moving machine parts;

2.2.14.1.3. Not be easily removable by the worker;

2.2.14.1.4. Offer maximum visibility of the point of operation consistent with operational and maintenance requirements; and

2.2.14.1.5. Be affixed to the machine. Where possible, they will be of the hinged type to enhance maintenance or adjustments.

2.2.14.2. When a point-of-operation guard cannot be used because of unusual shapes or cuts, jigs or fixtures that will provide equal safety for the operator will be used. Upon completion of an unusual operation, the guard will be immediately replaced.

2.2.14.3. Whenever a guard is removed for other than an operational requirement, the machine will be shut down and the control switches locked and tagged in the **OFF** position.

2.2.14.4. Whenever possible, enclosure and barrier guards shall be interlocked with the machine control so the machine cannot be activated unless the guard itself or the hinged or movable sections of the guard are in position.

2.2.14.4.1. The guard shall prevent the operator from opening the interlocked section and reaching into the point of operation.

2.2.14.4.2. Only personnel authorized by the shop supervisor shall make adjustments.

2.2.14.4.3. Guards that are interlocked with the machine cycle shall, when opened, stop the related component, interrupt the machine cycle, or shut down the machine. Closing the guard shall not restart the machine cycle except when the guard is designed for that purpose.

2.2.14.5. When the periphery of the blades of a fan are less than 7 feet above the floor or working level, the blades will be guarded. The guard will have openings no larger than one-half of an inch in width and depth. The use of concentric rings, with spacing between them not exceeding one-half of an inch, is acceptable providing that radial spokes and firm mountings are used to make the guard rigid enough to prevent it from being pushed into the fan blade. The use of nylon mesh or similar materials with holes not exceeding one-half of an inch to modify a substandard fan guard is acceptable providing the combination of the two provides protection from contact with the blade. The mesh must not be able to be pushed into the fan blade during normal use.

2.2.14.6. An enclosure guard provides the greatest degree of protection against moving parts of transmission apparatus. Any enclosure is satisfactory provided it is strong enough to withstand the bumps and pressure imposed on it without collapsing against the mechanism it covers. (29 CFR 1910.212 and .219, *Mechanical Power-Transmission Apparatus)*

2.2.14.6.1. The guard will be designed and installed so no part of the body can be inadvertently placed in, on, under, or over the edges of the guard where it might contact a moving part. (29 CFR 1910.212)

2.2.14.6.2. Guards shall be made of expanded metal; perforated or solid sheet metal; or wire mesh, plastic, or other material of equal or greater strength. Material used will be free from burrs or sharp edges. Guards will be fastened to the framework of the machinery. In certain

environments where chemical or corrosive operations are performed, it may be necessary for the installation civil engineer, the ground safety officer, or the bioenvironmental engineer (BEE) to determine the best material to be used for guard construction.

2.2.14.6.3. The enclosure guard and its supports shall be designed and installed so an adult person leaning on, or falling against, the enclosure will not receive an injury from the moving part.

2.2.14.6.4. Where there is a reasonable possibility of the moving part failing and causing injury, the enclosure shall be capable of containing the broken parts. Broken chains, belts, gears, and couplings will throw objects when fracture occurs. Part failure commonly occurs in operations involving frequent starting, stopping, reversing, and cyclic shock or peak loads that exceed normal operational loads. Parts that run at high revolutions per minute (rpm) are potential projectile hazards. When part failure is considered a hazard, the guard filler material will be a solid metallic sheet, plate stock, or casting. Sheet or molded plastics or other non-metallics will not be used unless they have been impact-tested to resist penetration of a specific failing part.

2.2.14.6.5. Openings to permit lubrication, adjustment, or inspection will have hinged, sliding, or bolted cover plates that will be closed prior to starting the machine.

2.2.14.6.6. Horizontal belts and ropes above floors or platforms will be guarded for their entire length if located over passageways or workplaces, if center-to-center distance between pulleys is 10 feet or more, or if the belt is 8 inches or more in width.

2.2.14.6.7. Vertical belts running over a lower pulley above the floor or platform will be guarded at the bottom in the same manner as overhead belts.

2.2.14.6.8. Where loose pulleys or idlers are not practical, belt perches in the form of brackets, rollers, etc., will be used to keep idler belts away from the shafts. Perches will be of strong materials and designed for the safe shifting of belts.

2.2.14.6.9. Belt dressing should not be applied when the belt or rope is in motion. However, if necessary, it will be applied where belts leave the pulleys, not where they approach them.

2.2.14.6.10. Unless the distance to the nearest fixed pulley, clutch, or hanger exceeds the width of the belt used, a guard will be provided to prevent the belt from leaving the pulley on the side where insufficient clearance exists. Where there are overhanging pulleys on a line, jack, or countershaft, with no bearing between the pulley and the outer end of the shaft, a guard to prevent the belt from running off the pulley will be installed.

2.2.14.6.11. Pulleys with cracks or pieces broken out of rims will be taken out of service.

2.2.14.6.12. Pulleys used in areas where they would be exposed to corrosion will be made of corrosion-resistant material. Pulleys located in corrosive environments will be inspected semiannually to ensure they are in satisfactory condition.

2.2.14.6.13. Vibration is a recognized hazard potential, and in installations where components frequently pass through high-vibration levels, there is danger of rotating shafts fracturing. Guards that vibrate at high frequencies can become dislodged from their mountings. Operators and maintenance personnel must pay close attention to the integrity of guards.

2.2.14.6.14. Exhaust hoods may serve as guards for the top, bottom, backside, and underside of table saws and the wheels of bandsaws, provided they meet the construction criteria for guards.

2.2.15. Related Equipment. While these aids do not give complete protection from machine hazards, they could provide the operator an extra margin of safety. Since these aids are not used instead of the safeguards, sound judgment is needed in their application.

2.2.15.1. Shields may be used to provide protection from flying particles.

2.2.15.2. Holding tools designed to aid material placement in and out of machinery shall be used when it would otherwise be necessary to place hands in the danger zone. These tools are not to be considered a substitute for guarding required by this or any other AFOSH machine standard. They will be used to supplement guard protection provided.

Chapter 3

METALWORKING MACHINERY

3.1. Hazards and Human Factors:

3.1.1. The primary hazards associated with metalworking machinery are at the point of operation where cutting tools, other machine components, or stock are rotating or cycling at high rates of speed. Lacerations to fingers from being caught in, on, or between the points of operation are the most common injuries. Other hazards that account for a wide variety of injuries, amputations, fractures, punctures, burns, and eye and ear damage are:

3.1.1.1. Slippery floor surfaces from oil and grease leakage and coolant splashing.

3.1.1.2. Flying particles and objects, such as hot and sharp chips, coolant, and dislodged machine and auxiliary parts.

3.1.1.3. Excessive noise level.

3.1.1.4. Exposed gears, belt drives, and clutch mechanisms.

3.1.1.5. Heavy material and auxiliary device movements, e.g., power press dies and lathe chucks.

3.1.1.6. Handling of extremely hot materials.

3.1.1.7. Loose clothing, jewelry, hair, etc.

3.1.1.8. Inadequate lighting.

3.1.2. The majority of metalworking machinery injuries result from human failures. Examples are distraction, fatigue, worry, anger, illness, and deliberate risk-taking. Other factors that result in injuries include inadequate training, failure to follow safe operating practices, improper machinery maintenance, inadequate supervision, substandard environmental controls, and overloading of machines.

3.2. Requirements:

3.2.1. Power Presses. Mechanical power presses come in many different sizes and types, but they all perform the same basic functions, e.g., forming, punching and shearing, or assembling metal or other material. They accomplish these functions by dies or tools mounted to a slide. The slide travels toward and away from a stationary anvil upon which the material is placed. The frame of the press guides the slide's path of travel. The slide's motion is provided through a crankshaft-clutch-motorized flywheel apparatus, for example, the clutch engages, energy is transmitted from the flywheel to the crankshaft, which in turn moves the slide. All power presses are divided into two categories depending on the type of clutches they are equipped with. The two types of clutches are full revolution and part revolution. The full revolution type, once activated, makes one complete revolution of the crankshaft that causes a full cycle of the slide before the clutch can be disengaged. The part revolution type can be disengaged at any point before the crankshaft has a full revolution and full stroke of the slide. Although direct drive presses have no clutch, they can be stopped at any point by de-energizing the drive motor. Therefore, they are considered a part revolution-type press. (29 CFR 1910.217, Appendix D, *Nonmandatory Supplementary Information*)

3.2.1.1. Supervisors shall ensure either a fixed barrier guard, safeguard device, or combination of both is installed and used on every operation when the opening between the die (tool) and base

(anvil) is more than one-fourth of an inch. The functional manager and installation ground safety personnel must approve guarding by location. The use of hand-feeding tools, regardless of size, does not replace a guard or device.

3.2.1.2. A guard is the most effective form of protection, if designed and constructed to prevent entry of hands or fingers into the point of operation. They shall not permit a worker to reach through, over, under, or around the guard. If a guard is installed and functions correctly, no other device is required. Following are four of the most common types of guards used on power presses.

3.2.1.2.1. A die enclosure guard is a barrier attached to the die shoe.

3.2.1.2.2. A fixed barrier guard is a guard attached to the press frame or base (anvil).

3.2.1.2.3. An interlocked barrier guard is attached to the press frame and base and has hinged or movable sections. The guard itself or the hinged or movable sections are locked in the closed position. The interlock also prevents opening the guard or the movable sections as long as the slide is in motion. The hinged or movable sections of the guard are intended for infrequent use such as setup or adjustment and not for manual feeding.

3.2.1.2.4. An adjustable barrier guard is attached to the press bed, base or die shoe, and requires adjustment for each job or die setup. Personnel authorized by the shop supervisor perform adjustments.

3.2.1.3. Since fixed guarding is not always possible due to the nature of an operation, devices are acceptable as a means of protection against point-of-operation hazards. When the following devices are properly installed and function properly, no other point-of-operation guarding is required unless the operation is such that a combination of guards or devices is necessary.

3.2.1.3.1. A movable barrier or gate device resembles an interlocked barrier guard in appearance since it is interlocked into the press clutch so slide motion cannot be initiated unless the gate is closed. There are two types of gates.

3.2.1.3.1.1. Type A gate must enclose the point of operation before a stroke can be initiated and remain closed as long as the slide is moving.

3.2.1.3.1.2. Type B gate prevents entry only during the downstroke and must prevent access prior to the start of the motion or die closure.

3.2.1.3.2. Pull-out devices consist of operator wristbands connected by cords and linkage to the slide or upper die so, when the die descends, the operator's hands will be automatically withdrawn from the point of operation if the worker has not already withdrawn them. Closer supervision is required to ensure their use and proper alignment.

3.2.1.3.3. Holdout or restraint devices consist of attachments for each of the operator's hands. These devices are securely anchored and adjusted to prevent the operator from reaching into the point of operation at any time.

3.2.1.3.4. Presence-sensing devices are restricted for use only on part revolution clutch presses. A presence-sensing device is a light curtain or other type sensing field between the operator and the point of operation interlocked into the control system so slide motion is prevented or stopped prior to die closure if the operator's hands or any part of the body is within the sensing field. Areas not protected by the presence-sensing devices must be guarded.

NOTE: Presence-sensing devices shall not be used on machines using full revolution clutches, e.g., power presses, or used as a tripping means to initiate motion.

3.2.1.3.5. Sweep-type devices cannot be used as a single safeguard for point-of-operation guarding. These devices consist of single or double arms or rods attached to the slide of the presses to push the operator's hands away from the point of operation as the slide descends.

3.2.1.4. Two-hand control devices are normally used on presses with a part revolution clutch. The operator must depress two buttons concurrently to initiate slide motion. The buttons must be depressed continuously (holding time) on the downstroke or else the clutch is disengaged, the brake is applied, and the slide stops.

3.2.1.4.1. Two-hand trip devices, once pressed, do not have to be held during the downstroke, and the slide will stop only after it has completed a full cycle. The device is generally applicable to full revolution clutch presses.

3.2.1.4.2. In addition to proper design, installation, and correct operation, two-hand trips and presence-sensing devices shall be located far enough away from the point of operation (depending on the stopping time of the press) that when operators release the control buttons or disturb the presence-sensing field, they do not have time to reach into the point of operation before the die closes or slide stops.

3.2.1.4.3. A control reliability system detects a failure within the controls and prevents initiation of a successive stroke until the failure is corrected.

3.2.1.4.4. A brake monitor system monitors the performance of the brake on each stroke and automatically prevents the activation of a successive stroke if the stopping time or braking distance has deteriorated beyond the predetermined safe stopping distance.

3.2.1.4.5. Safeguarding devices such as two-hand controls, presence-sensing device, type B gate, or movable barriers allow the operator to feed or remove parts by placing one or both hands in the point of operation. Therefore, when these devices are used on part revolution clutch presses, the control reliability system and brake monitor system are required to ensure operators' safety from the point-of-operation hazard.

3.2.1.4.6. The energy controls shall be isolated by a lockout device and safety blocks installed during machine repairs or alterations of the die area.

3.2.1.4.7. Single or dual hand-lever-operated power presses will be equipped with a spring latch on the operating lever to prevent premature or accidental tripping.

3.2.1.4.8. The operating levers on hand-tripped machinery with more than one operating station will be interlocked so the machine can only be tripped when all levers are actuated concurrently.

3.2.1.4.9. A means of selecting **OFF**, **INCH**, **SINGLE STROKE**, or **CONTINUOUS** modes of operation (as applicable) will be integrated with the clutch and (or) brake control to govern the operation mode of the presses.

3.2.1.4.10. During the **inch** operating mode, exposure of the worker's hands to the point of operation will be protected by one of the following:

3.2.1.4.10.1. Requiring the concurrent use of both hands to actuate the clutch; or

3.2.1.4.10.2. Use of a single control protected against accidental actuation. **NOTE:** The control will be located so the worker cannot reach into the point of operation while actuating the control.

3.2.1.4.11. Two-handed controls for single-stroke press machines will ensure safe operation by design, construction, and (or) separation so:

3.2.1.4.11.1. The concurrent use of both hands is required to trip the press.

3.2.1.4.11.2. Machine adjustment can be made, but the concurrent use of both hands is required during the die closing portion of the stroke.

3.2.1.4.11.3. Repetitive operation is not possible unless the controls are activated in proper sequence. The control systems will require that all operators' hand controls are released before an interrupted stroke can be resumed.

3.2.1.4.12. Individual operator's two-hand trip controls will be designed and constructed to require the use of both hands to protect against unintentional operation. A control arrangement requiring concurrent operation of both the individual operator's hand controls will be used. Bypass of control interlocks is prohibited.

3.2.1.4.13. Two-hand trip systems on full-revolution-clutch machines shall provide anti-repeat protection for operators. When two-hand trip systems are used on multiple operator machines, each operator will have a separate set of controls.

3.2.1.4.14. Picks, pliers, tongs, and other handfeeding tools required for the safe handling of stock, dies, or materials shall be provided to the operators to supplement other guards. These tools will not eliminate the need for required protective clothing, equipment, or machine guarding. Additionally, a die setter's safety bar will be used for turning the flywheel when the power is off.

3.2.1.4.15. As an alternative or supplement to other guarding methods, individual die guards shall be attached to the die shoe, stripper, or die block in a fixed position. They will be designed so the operator cannot reach over, under, or around the guard into the danger zone.

3.2.1.4.15.1. Attachment points will be provided on dies requiring mechanical handling.

3.2.1.4.15.2. Die stops or other means will be used on inclined presses to prevent inadvertent movement of the die while setting or removing them.

3.2.2. Hydraulic Press. Hydraulic power presses shall be safeguarded to prevent the operator's hands from being placed between the dies during press cycling. The types of safeguards used include safeguarding by location or distance (paragraph **2.2.12.**), safeguarding by device (paragraph **2.2.13.**), and safeguarding by barrier or enclosure (paragraph**2.2.14.**).

3.2.2.1. Ensure controls meet the requirements of paragraphs **3.2.15.** and **3.2.16.** The following additional features apply to hydraulic press controls.

3.2.2.1.1. When two-hand control systems are installed, they shall incorporate an anti-repeat feature.

3.2.2.1.2. A **Stop and Auto Return** switch, when provided, shall be color-coded yellow. Since it does not deactivate power or other controls, a power disconnect or **Stop** switch, capable of being locked, shall be provided.

3.2.2.2. Control energy sources as referenced in paragraph **2.2.11.**

3.2.2.3. Ensure pneumatic and hydraulic systems meet the requirements of paragraph **3.2.19.**

3.2.2.4. Refer to paragraph **3.2.22.** for requirements on safeguarding hydraulic presses that are equipped with automatic material clamping equipment.

3.2.3. Press Brakes. The design and construction of a press brake are different from other **ram function** metalworking machines. The bed and ram, which are longer than other machines, are located in front of and extend beyond the machine's frame. This permits a much larger working area. Press brakes can be hydraulic or mechanical and are classified as either general purpose or special purpose. The operators for both types of machines control the speed of the ram. One worker operates general machines.

3.2.3.1. Controls shall meet the requirements of paragraphs **3.2.15.** and **3.2.16.**

3.2.3.2. Energy sources shall be controlled as referenced in paragraph **2.2.11.**

3.2.3.3. Pneumatic and hydraulic systems shall meet the requirements of paragraph **3.2.19.**

3.2.3.4. Safeguarding the point of operation will depend on the operation being performed. Proper safeguarding must be planned and installed by someone knowledgeable of both press brakes, in general, and the specific operation. A point-of-operation device (paragraph **2.2.13.**) or a point-of-operation barrier or enclosure (paragraph **2.2.14.**) will guard the point of operation. Guarding by a safe distance (for example, maintaining a safe distance between the point of operation and a worker's hand and fingers as he or she supports the stock) can only be used when barriers, enclosures, or devices are not possible. The functional manager must approve guarding by safe distance. The supervisor shall ensure safeguards are available and used on either type of machine. The operator must select and use and proper guarding system for the material and work being performed. The following requirements will be used based upon the type of safeguard available and installed for the operation:

3.2.3.4.1. Safeguarding by Distance or Location — paragraph 2.2.12.;

3.2.3.4.2. Safeguarding by Device — paragraph 2.2.13.;

3.2.3.4.3. Related Tools — paragraph 3.2.20.;

3.2.3.4.4. Safeguarding of Power Transmission Equipment — paragraph 3.2.21.; and

3.2.3.4.5. Powered Clamping, Working Holding Devices — paragraph 3.2.22.

3.2.4. Shapers, Forming Rolls, Calenders, and Cold Headers:

3.2.4.1. Controls shall meet the requirements of paragraphs 3.2.15. and 3.2.16.

3.2.4.2. Energy sources shall be controlled as referenced in paragraph 2.2.11.

3.2.4.3. All pneumatic and hydraulic components shall be designed and maintained to meet paragraph 3.2.19. requirements.

3.2.4.4. The primary function of safeguards on these machines shall be to protect the operator's hands, fingers, and other body parts from contacting the point of operation and slide mechanisms. Adjustable barrier or enclosure safeguards will be used to the maximum extent possible. Safeguarding by location or distance should not be considered for these machines because of the fre-

quent operations requiring the worker to hold the workpiece. Regardless of the type selected, the requirements of paragraphs 2.2.13. and 2.2.14. will be used in evaluating the safeguard.

3.2.4.4.1. The rear of the reciprocating ram will be guarded to protect other employees. Additional barrier guards shall be provided at the refuse drop areas.

3.2.4.4.2. A chip guard will be provided to prevent flying chips from striking the operator or other workers. **NOTE:** All material will be securely clamped in position on the machine table.

3.2.5. Shears. There are two types of shears used in metalworking shops: powered and mechanical. Since both types perform the same basic function, safeguarding requirements for point of operation, movable parts, pinch points, and scrap deposit areas are also the same. Safeguarding shall be provided to protect the operators from the hazardous areas.

3.2.5.1. Controls shall meet the requirements of paragraphs 3.2.15. and 3.2.16.

3.2.5.2. Energy sources shall be controlled as referenced in paragraph 2.2.11.

3.2.5.3. Pneumatic and hydraulic systems shall meet the standards of paragraph 3.2.19.

3.2.5.4. Barrier or enclosure guarding shall be considered the primary means of safeguarding shearing machines. Location or distance safeguarding may be considered but is normally not applicable due to the varying operations performed on shearing machines — paragraphs 2.2.13., 2.2.14., and 3.2.20. through 3.2.22. shall be used to evaluate the adequacy of installed guards or devices. The area where sheared or punched refuse drops will be barricaded to prevent injuries to operators and helpers. Subject machines will be equipped with an emergency stop control. (Refer to paragraph 3.2.18. for requirements.)

3.2.6. Lathes, Screw/Bar, and Chucking Machines. The point of operation does not normally require protection for a lathe, single-spindle screw/bar, or chucking machine when operating in the manual mode. However, multiple-spindle machines are normally equipped with enclosures that isolate the point of operation from the operator. Additional hazard areas of all machines and operations that require safeguarding include powered work-holding devices, powered turrets, and controls and operations where workpieces extend beyond the confines of the workspace.

3.2.6.1. Controls shall meet the requirements of paragraphs 3.2.15. and 3.2.16.

3.2.6.2. Energy sources shall be controlled as referenced in paragraph 2.2.11.

3.2.6.3. Pneumatic and hydraulic systems, when installed, shall meet the paragraph 3.2.19. standards.

3.2.6.4. A fixed or movable barrier device or awareness device shall be installed when a lathe operates in the automatic or semi-automatic mode and a tool trapping space is created by the automatic advancing of rotating and nonrotating components.

3.2.6.5. Power-indexed turrets containing an exceptionally long tool or tool-holding device that extends in the operator's workspace, shall have a barrier guard, rigid awareness barrier (protective railing), or awareness device installed during machine operation. One of these safeguards shall also be installed when a rotating workpiece extends beyond the normal confines of the machine. Guards or devices are not required when tracing is being performed and the operator must initiate each cycle.

3.2.6.6. All lathes procured after the date of this standard shall be equipped with a spindle braking device if the operator must stop the spindle to manually unload a workpiece.

3.2.6.7. Chucks will always be started on the lathe spindle by hand.

3.2.6.8. The tail stock end of the work will be countersunk deeply enough so there is minimal chance of the work being torn loose.

3.2.6.9. Tools will be adjusted in the tool rest so they are slightly above the center to keep the work from climbing. An exception is threadcutting where the tool should be at center.

3.2.6.10. Chips that are in the process of being generated, such as long stringy chips, shall not be removed by hand. A tool, puller, brush, or shovel shall be used.

3.2.6.11. Operators will not attempt to brake the lathe by grasping the chuck, work, or any other machine component.

3.2.7. Drilling, Milling, and Boring Machines. A barrier guard or guarding device shall be installed and used when machines are operated in an automatic or semi-automatic mode, cutting devices are exposed, and any part of the operator's body is within 1 foot of the cutting device. Awareness barriers can also be used; however, only in situations when a guard or guarding device would, of itself, present a hazard. Point-of-operation and tool-trapping space guarding is not required when machines are operated in the manual mode. The type of guarding will depend on the machine, location, and operation. Additionally, shields may be required to protect workers from chips and splashing coolant. The requirements identified in paragraph **3.2.20.** shall apply to the design and installation of shields. Additionally, the following requirements for guards, machine components, and operations apply.

3.2.7.1. Operators shall not hand-hold stock while using these machines. When the cutting tool contacts the stock or workpiece, it can catch or twist the material from the operator's grasp. The resulting uncontrolled rotation of the stock will cause injury to the operator. A hold-down fixture or stock vise shall be used to prevent these injuries.

3.2.7.2. Drill chucks shall not have protruding set screws.

3.2.7.3. Auxiliary devices, e.g., index heads, vises, drill or boring bits, and extra tools, should be properly stored.

3.2.7.4. Drill presses will not be operated at a speed greater than specified by the press or drill manufacturer for the particular material to be drilled.

3.2.7.5. Automatic and high production drilling machines will be equipped with barricades or enclosures to separate operators and other personnel from drilling operations. When steps or stairs are necessary for making adjustments to the machine or work, they should be well constructed, provided with nonslip treads, and in good repair.

3.2.7.6. Controls shall meet the criteria of paragraphs 3.2.15. and 3.2.16.

3.2.7.7. Energy sources shall be controlled as referenced in paragraph 2.2.11.

3.2.7.8. When provided, pneumatic and hydraulic systems shall conform to paragraph 3.2.19.

3.2.8. Planers. The reciprocating work and table will be barricaded, or enclosed, to prevent personnel from being struck by material that is turning against the cutter.

3.2.8.1. A chip shield will be provided to prevent chips from flying and striking the operator or other workers.

3.2.8.2. Safety dogs will be placed at each end of the planer table to prevent the table from running off the gear rack.

3.2.8.3. All material will be securely clamped in position on the planer table.

3.2.9. Saws. Safeguarding of metalworking saws varies depending on the type of machine and material being processed. The general requirements of paragraphs **3.2.15.** through **3.2.19.** apply to all saws. The following paragraphs address the three most common types of saws used in Air Force shops. For saws not covered, the supervisor and installation ground safety personnel shall develop requirements on machine safeguards. (ANSI Standard B11.10, *Metal Sawing Machines*.)

3.2.10. Bandsaws:

3.2.10.1. Both upper and lower wheels will be completely enclosed on both sides. The enclosures should be easily removed to permit saw blade maintenance.

3.2.10.2. The working part of a saw blade, between the guide rolls and the upper wheel enclosure, will be guarded to prevent accidental contact with the saw blade. The guard will be self-adjusting and attached to the gauge so that, in any position of the gauge, the guard will completely cover the portion of the saw blade between the guide rolls and the upper wheel enclosure.

3.2.10.3. Saws will be equipped with an automatic tension control to compensate for the contraction that takes place in the cooling of the blade after a job is finished and to ensure proper tension of the saw blade.

3.2.10.4. Feed rolls on self-fed bandsaws will be guarded to prevent the hands of the operator from coming into contact with the in-running rolls at any point.

3.2.10.5. The saw speed will not exceed the safe limit recommended by the manufacturer.

3.2.11. Hacksaws:

3.2.11.1. Loss of coolant and lubricants from a power hacksaw shall be minimized by proper maintenance of the coolant system and the installation of splash shields.

3.2.11.2. Vises, fixtures, and other work-holding equipment shall be used to hold the workpiece securely.

3.2.11.3. Stock being cut by a power hacksaw will not be hand-held.

3.2.12. Circular Metal Saws:

3.2.12.1. The safeguard shall be of sufficient strength to protect the operator from a broken saw blade or teeth.

3.2.12.2. It shall enclose the spindle end and nut.

3.2.12.3. It shall be provided with an opening or means of removing chips that, in itself, will not create a hazard to the operator.

3.2.12.4. It shall enclose all unused portions of the exposed saw blade. The part of the blade used for cutting shall be protected by a barrier. The barrier shall be positioned to protect the operator from exposure to the blade.

3.2.12.5. Loss of coolant and lubricants from the machine shall be minimized by proper maintenance of the coolant system and the installation of splash shields.

3.2.12.6. Vises, fixtures, and other work-holding equipment shall be used to hold the workpiece securely.

3.2.12.7. All circular sawing machines shall be equipped with a pair of flanges.

3.2.13. Cut-Off and Contour Saws:

3.2.13.1. Both the upper and lower wheels on both sides of saws will be enclosed. The enclosure should be hinged to permit easy access to the saw blade.

3.2.13.2. The working part of the saw blade, between the guide rolls and the upper wheel enclosure, will be guarded to prevent accidental contact with the saw blade. The guard will be self-adjusting and will be attached to the gauge so that, in any position of the gauge, the guard will completely cover the portion of the saw blade between the guide rolls and the upper wheel enclosure.

3.2.13.3. Abrasive cut-off saws will be connected to an exhaust system.

3.2.13.4. Stock being cut by a power hacksaw will not be hand-held.

3.2.14. Riveting Machines. A guard will be provided to prevent the operators from placing their hands between dies.

3.2.15. Operator Controls:

3.2.15.1. Controls shall be within easy reach of the machine operator. They shall be placed so the worker does not have to reach past moving parts that may cause injury.

3.2.15.2. Controls shall be positioned or protected against accidental or inadvertent operation. (29 CFR 1910.217b(8)(ii))

3.2.15.3. Controls shall not be wedged for continuous operation.

3.2.15.4. Controls shall be clearly identified when their function is not self-evident. They shall not initiate any motion unrelated to its designation.

3.2.15.5. Jog circuits, if used, shall be designed to prevent continuous run or automatic operation.

3.2.15.6. Foot (treadle) controls shall be protected against unexpected and accidental tripping. These controls shall have a nonslip surface.

3.2.15.7. Energy sources shall be controlled as referenced in paragraph **2.2.11.**

3.2.16. Mechanical Controls:

3.2.16.1. Handwheels that are turned in a clockwise rotation shall produce for the controlled component a linear movement to the right, away, or upward. If rotary motion is produced by the handwheel, clockwise rotation shall cause clockwise movement of the controlled component.

3.2.16.2. Control levers shall move in the same direction as the controlled component when both motions are parallel.

3.2.16.3. When crank and handwheel controls with protrusions rotate at more than 50 surface feet per minute, they shall have an adjustable barrier guard installed.

3.2.17. Multiple Control Stations:

3.2.17.1. When a setup control station is provided in addition to the normal operator's control station, selection of the setup station shall render the operator's station inoperative, except for emergency stop. Switching from one control station to another shall not create a hazard.

3.2.17.2. When more than one operator is required to operate the machine from different control stations, each station shall be provided with a cycle start button that must be depressed concurrently in order to initiate the cycle.

3.2.17.3. When one operator can operate the machine from more than one station, all cycle start buttons other than the one being used shall be made inoperative.

3.2.17.4. Where parts are manually loaded and the operator may be exposed to a hazard due to cutter or machine table movements, the rapid traverse from one part or position to the other shall be initiated by the operator.

3.2.18. Emergency Stop Control:

3.2.18.1. All machines shall incorporate one or more emergency stop controls that, upon momentary operation, shall de-energize all machine motions. These emergency stops shall be located at each operator control station and, if inherent hazards are present at other operating positions, an emergency stop should be provided.

3.2.18.2. The emergency stop shall be color coded red.

3.2.18.3. The emergency stop control shall override all other controls and, when actuated, not create other hazards.

3.2.18.4. All machine motions stopped by the emergency or master switch shall be restartable only by deliberate action by the operator.

3.2.19. Pneumatic and Hydraulic Systems:

3.2.19.1. Circuits shall be designed and components selected, applied, and adjusted so loss of control media (fluid, air, etc.) will not cause a hazard.

3.2.19.2. Circuits shall be designed and components applied so pressure variations will not cause a hazard.

3.2.19.3. Components shall be used that cannot be adjusted outside the safe working range of the circuit.

3.2.19.4. Means shall be provided to prevent operation when loss of working pressure could cause a hazard.

3.2.19.5. Circuits employing accumulator tanks shall automatically vent the accumulator pressure or isolate the accumulator when the machine is shut off.

3.2.19.6. Nonvented accumulators shall be identified with a sign that says **"WARNING PRESSURIZED VESSEL"** or the nearest commercially available equivalent. Charging and discharging information for proper servicing of nonvented accumulators shall be given on or near the accumulator (in a visible location) and in the maintenance manual.

3.2.19.7. Gas-charged accumulators operating above 200 pounds per square inch, gauge (psig) charging pressure shall be charged with inert gas.

3.2.19.8. Flexible hoses shall be arranged so they will not create a tripping hazard. Where failure of flexible hoses may constitute a whipping hazard, they shall be restrained or contained.

3.2.19.9. Whenever pressure is maintained after power is off, such as in counterbalance or accumulator circuits, a warning plate shall be used and procedures for depressurizing the circuit shall be noted in the maintenance manual.

3.2.20. Related Equipment. While these aids do not give complete protection from machine hazards, they could provide the operator an extra margin of safety. Since these aids are not used instead of the safeguards, sound judgment is needed in their application.

3.2.20.1. Shields may be used to provide protection from flying particles. When chips or coolant fluids are splashed on the operator or on the work area and passageway floor, a splash shield shall be installed.

3.2.20.2. Holding tools designed to aid material placement in and out of machinery shall be used when it would otherwise be necessary to place hands in the danger zone. These tools are not to be considered a substitute for guarding required by this or any other AFOSH machine standard. They will be used to supplement guard protection provided.

3.2.20.3. Awareness barriers do not provide physical protection, but serve only to remind a person that he or she is approaching the danger area. Generally, awareness barriers are not considered adequate where continual exposure to the hazard exists.

3.2.21. Transmission Belts and Pulleys:

3.2.21.1. Horizontal belts and ropes above floors or platforms will be guarded for their entire length if located over passageways or workplaces, if center-to-center distance between pulleys is 10 feet or more, or if the belt is 8 inches or more in width.

3.2.21.2. Vertical belts running over a lower pulley above the floor or platform will be guarded at the bottom in the same manner as overhead belts.

3.2.21.3. Where loose pulleys or idlers are not practical, belt perches in the form of brackets, rollers, etc., will be used to keep idler belts away from the shafts. Perches will be of strong materials and designed for the safe shifting of belts.

3.2.21.4. Belt dressing should not be applied when the belt or rope is in motion. However, if necessary, it will be applied where belts leave the pulleys, not where they approach them.

3.2.21.5. Unless the distance to the nearest fixed pulley, clutch, or hanger exceeds the width of the belt used, a guard will be provided to prevent the belt from leaving the pulley on the side where insufficient clearance exists. Where there are overhanging pulleys on a line, jack, or countershaft, with no bearing between the pulley and the outer end of the shaft, a guard to prevent the belt from running off the pulley will be installed.

3.2.21.6. Pulleys with cracks or pieces broken out of rims will be taken out of service.

3.2.21.7. Pulleys used in areas where they would be exposed to corrosion will be made of corrosion-resistant material. Pulleys located in corrosive environments will be inspected semiannually to ensure they are in satisfactory condition.

3.2.22. Powered Clamping, Work Holding Devices. These shall be provided with a safeguard to warn the operator or contain the workpiece when there is a lack of clamping pressure. An electrical

interlock can be installed which shuts power to the lathe when hydraulic pressure drops or electrical interruption occurs. A retaining cover or barrier guard can also be used. Another method for protecting personnel is an audible or visual warning device that shall be visible or audible to the operator at his normal work position.

Chapter 4

PERMANENTLY INSTALLED GRINDING MACHINES

4.1. Hazards and Human Factors:

4.1.1. Hazards. Personnel injuries and property damage can result from the improper use, care, or storage of abrasive wheels and associated equipment.

4.1.1.1. Material failure hazards include:

4.1.1.1.1. Improper mounting of wheels to machinery.

4.1.1.1.2. Excess pressure on work surface causing heat and vibration that leads to abrasive wheel deterioration or destruction.

4.1.1.1.3. Use of wheels at speeds greater than manufacturer's ratings.

4.1.1.1.4. Improper storage practices causing damage to wheels.

4.1.1.1.5. Wires expelled from brush wheels.

4.1.1.1.6. Particles ejected or thrown from the material being worked.

4.1.1.1.7. Vibration that may burst wheels or disks.

4.1.1.2. Procedural hazards include:

4.1.1.2.1. Holding the work incorrectly.

4.1.1.2.2. Using the wrong type of wheel.

4.1.1.2.3. Grinding on the side of the wheel that is not designed for side wheel grinding.

4.1.1.2.4. Taking too heavy a cut.

4.1.1.2.5. Applying work too quickly to a cold wheel or disk.

4.1.1.2.6. Grinding too high above the center of a wheel.

4.1.1.2.7. Failing to use wheel washers (blotters).

4.1.1.2.8. Incorrectly adjusting or lacking a work rest.

4.1.1.2.9. Using spindles of incorrect diameter or with the threads cut so the nut loosens as the spindle revolves.

4.1.1.2.10. Installing flanges of the wrong size, with unequal diameters, or unrelieved centers.

4.1.1.2.11. Dressing of wheels incorrectly, resulting in off-center conditions or fracture strains.

4.1.2. Human Factors. Worker and supervisor attitudes and attentiveness are important factors in working safely with abrasive wheel machinery. Monotony and fatigue interact when repetitive work is performed over a long period of time. Exposure to noise, heat, dust, and vibration is frequently present. Constant operator attention is essential. Some of the human factors related situations and mishaps associated with abrasive wheel operations are:

4.1.2.1. Eye and face injuries when face shields or goggles are not used in addition to the shield mounted on the grinder.

4.1.2.2. Injury to body parts when contact is made with revolving wheels or unguarded moving parts, with monotony and fatigue as contributing factors.

4.1.2.3. Respiratory problems caused by inhalation of abrasive wheel dust and failure to use face respirators where required.

4.1.2.4. Hearing loss caused by exposure to noise in excess of threshold limit values and failure to use hearing protection devices supplied for this purpose.

4.2. Requirements:

4.2.1. Exhaust Ventilation. Wherever dry grinding, polishing, or buffing is performed and employee exposure (without regard to the use of respirators) exceeds permissible exposure limits, a local exhaust ventilation system shall be provided and used to maintain employee exposures within permissible exposure limits, (29 CFR 1910.94(b)(2), *Ventilation*). The installation BEE will determine whether exhaust ventilation is needed. When required, exhaust systems will conform to the criteria in AFOSH Standard 48-2.

4.2.2. Wheel and Spindle Speeds:

4.2.2.1. The spindle rpm of grinders shall be shown on the machine in a location readily visible to the operator. (ANSI B7.1)

4.2.2.2. All grinding wheels shall have the operating speed affixed to the wheel. Those without a rating will be tagged and removed from service until the rpm rating is validated.

4.2.3. Safe Operating Procedures:

4.2.3.1. Abrasive wheel machines will not be operated unless safety guards are installed as outlined in paragraph 4.2.6. except wheels used for internal work where the work offers protection. Types 16, 17, 18, 18R, and 19 cones, plugs, and threaded hole pot balls are examples of those not requiring guards while used for internal work. (29 CFR 1910.215(a)(1), *Abrasive Wheel Machinery*)

4.2.3.2. Peripheral protectors, commonly referred to as tongue guards, shall be positioned so the opening between the wheel and the guard is no more than one-fourth of an inch. (Refer to paragraph **4.2.6.** for additional information on tongue guards.) (29 CFR 1910.215(b)(9))

4.2.3.3. Work rests shall be used during all off-hand grinding operations. They shall be of rigid construction and designed to be adjustable to compensate for wheel wear. (29 CFR 1910.215(a)(4))

4.2.3.3.1. Adjust these devices closely to the wheel with a maximum opening of one-eighth of an inch to prevent the work from being jammed between the wheel and the rest. Jamming of the work piece could break the wheel and cause personnel injury. Work rests shall be securely clamped after each adjustment and the adjustment shall not be made with the wheel in motion. In those instances where jamming or contact with a grinding wheel is precluded by the size of the work piece, a side guard offers sufficient protection to the operator. Accordingly, in such situations, the requisite to have a work rest adjusted to a maximum opening of one-eighth of an

inch is not obligated. However, the work rest clearance will not exceed the width of the work piece. (29 CFR 1910.215(a)(4))

4.2.3.3.2. Do not grind stock that is thin enough to be pulled between the work rest and the wheel.

4.2.3.4. Machines will be operated within rated speeds at all times. (29 CFR 1910.215(d)(1))

4.2.3.5. Wheels found defective, cracked, or out of balance will be taken out of service until repaired or discarded. Wheels shall be removed from service when they are worn to a size that would allow the flange assembly to contact the piece being ground or the work rest. (ANSI B7.1)

4.2.3.6. The operator will stand to one side whenever grinding machines are initially turned on, until the wheel has reached its operating speed, and when going from operating speed to the stopped position.

4.2.3.7. The machine should be stopped and inspected to determine the cause of chattering or vibration.

4.2.3.8. Abrasive grinding wheels will not be used to grind aluminum, brass, copper, or other soft metals unless the wheel is specifically designed for that purpose. Such wheels will be used to grind soft metals only.

4.2.3.9. Side wheel grinding will be accomplished only on wheels designed for that purpose.

4.2.3.10. Operators will ensure that grinders, buffers, and wire brush machines are turned off when work is completed or before leaving the vicinity of the machine.

4.2.3.11. Machine operators will not wear loose-fitting clothing that may become entangled in moving parts or power transmission apparatus.

4.2.3.12. The type of PPE required for abrasive grinding operations is dependent on the material being processed. As a minimum, operators will wear the proper eye and face protection (e.g., face shield, goggles, or spectacles) identified in AFOSH Standard 91-31. Shop aprons of heavy construction should be worn when operations are performed on a continuing or prolonged basis. Gloves should be worn when burrs or rough edges present a hazard to the worker's hands.

4.2.3.13. Wire brush wheel operators shall wear protective aprons of heavy construction and a face shield. Care must be exercised when gloves are used to ensure they are not snagged by the rotating brushes and pulled into the wheel.

4.2.3.14. Polishing and buffing wheel operators shall wear face shields.

4.2.4. Inspections. Grinding machines will be inspected prior to use. The following minimum items will be checked unless manufacturer's instructions require more stringent inspection criteria.

4.2.4.1. Work rest for security and proper adjustment, e.g., one-eighth of an inch maximum opening.

4.2.4.2. Wheels for security and condition, e.g., cracks, gouges, chipped edges, or uneven wear.

4.2.4.3. Wheels for evidence of side grinding or grinding of soft metals when the wheels are not designed for these purposes.

4.2.4.4. Shatter-resistant transparent shields for cleanliness, scoring, and proper placement.

4.2.4.5. Machine guards and power transmission guards for condition, security, and proper alignment.

4.2.4.6. Periphery (tongue) guards for security and proper adjustment, e.g., one-fourth of an inch maximum opening.

4.2.4.7. Proper lighting at point of operation.

4.2.5. Maintenance and Lubrication. Maintenance on grinding equipment shall not be accomplished until the machine power source is turned off and locked out or the power cord is unplugged.

4.2.5.1. Wheel Mounting. Incorrect mounting of an abrasive wheel is responsible for much wheel breakage. Compression forces, radial forces, and grinding heat cause stresses around the central hole of the wheel. It is most important that manufacturer's recommendations concerning size and design of mounting flanges and mounting techniques be followed prior to any maintenance.

4.2.5.1.1. Operating Speed. Before mounting the wheel, check the spindle speed of the machine to ensure it does not exceed the maximum operating speed marked on the wheel. (29 CFR 1910.215(d))

4.2.5.1.2. Shelf Life. Check that the shelf life requirements of the wheel have not been exceeded (if applicable).

4.2.5.1.3. Inspection. Visually inspect and perform a ring test on wheels. Defects such as broken, chipped, or gouged wheels can be easily detected, but cracks are frequently not visible to the naked eye. Tap wheels gently with a light nonmetallic implement such as the handle of a screwdriver for light wheels, or with a wooden mallet for heavier wheels. If they sound dead, a crack exists. Do not use them. This procedure is known as a ring test and is performed as follows: (29 CFR 1910.215(d)(1))

4.2.5.1.3.1. Ensure wheels are dry and free from sawdust when performing the ring test, otherwise they do not ring clear. Organic bonded wheels do not emit the same clear metallic ring as do vitrified and silicate wheels. (29 CFR 1910.215(d)(1)(i))

4.2.5.1.3.2. Tap wheels about 45 degrees at each side of the vertical centerline and about 1 or 2 inches from the periphery. Then rotate 45 degrees and repeat the test. A sound and undamaged wheel will give a clear ring. If cracked, there will be a dead sound. (29 CFR 1910.215(d)(1)(ii))

4.2.5.1.4. Arbor Size. Ensure grinding wheels fit freely on the spindle and remain free under all grinding conditions. Proper clearance between the wheel arbor hole and the machine spindle is essential to avoid excessive pressure due to mounting and spindle heat expansion. (29 CFR 1910.215(d)(2))

4.2.5.1.5. Surface Condition. Ensure all contact surfaces of wheels, blotters, and flanges are flat and free of foreign matter. Uneven mounting pressure against the side of a wheel causes stress that could lead to wheel failure. (29 CFR 1910.215(d)(3))

4.2.5.1.6. Reducing Bushing. If a bushing is used in the wheel hole, ensure it does not exceed the width of the wheel and does not contact the flange. (29 CFR 1910.215(d)(4))

4.2.5.1.7. Flanges. Mount all abrasive wheels between flanges that are not less than one-third the diameter of the wheel. Exceptions include: mounted wheels, threaded wheels (plug and

core), plate mounted wheels, and cylinder, cup, or segmental wheels mounted in chucks. (Refer to 29 CFR 1910.215(c)(1)) for detailed information on exceptions.)

4.2.5.1.7.1. Flanges shall be dimensionally accurate and in good balance. There shall be no rough surfaces or sharp edges. (29 CFR 1910.215(c)(3))

4.2.5.1.7.2. Both flanges shall be the same diameter and have equal bearing surface (figure 4.1.). Exceptions to this are type 27 and type 28 wheels. (Additional information on these exceptions may be found in 29 CFR 1910.215(c)(4).)

4.2.5.1.7.3. The driving flange shall be securely fastened to the spindle and the bearing surface shall run true. When more than one wheel is mounted between a single set of flanges, wheels may be cemented together or separated by specially designed spacers. Spacers shall be equal in diameter to the mounting flanges and have equal bearing surfaces. Blotters will not be used as spacers; normally soft copper or brass will be used. If wheels are to be cemented together, the wheel manufacturer's recommendation will be followed. (29 CFR 1910.215(c)(7) and ANSI B7.1)

4.2.5.1.7.4. All flanges shall be maintained in good condition. When the bearing surfaces become worn, warped, sprung, or damaged they will be trued and resurfaced. When resurfacing or trueing, material will not be removed from the flange to the point that it loses its rigidity. (29 CFR 1910.215(c)(9))

4.2.5.1.8. Blotters. Use blotters between flanges and abrasive wheel surfaces to ensure uniform distribution of flange pressure (**Figure 4.1.**). Exceptions include: mounted wheels, threaded wheels (plug and core), plate mounted wheels, and cylinder, cup, or segmental wheels mounted in chucks. (Refer to 29 CFR 1910.215(c)(6) for detailed information on exceptions.) When blotters are required, ensure they cover the entire contact area of wheel flanges. The proper thickness of blotters depends upon the type of material used. OSHA addresses only blotting paper (.025 thickness), but rubber, leather, and felt are all acceptable. Follow the manufacturer's recommendation. (29 CFR 1910.215(d)(5))

4.2.5.1.9. Multiple Wheel Mounting. When more than one wheel is mounted between a single set of flanges, cement wheels together or separate them by specially designed spacers. Spacers shall be equal in diameter to the mounting flanges and have equal bearing surfaces. When mounting wheels that have not been cemented together, or ones that do not utilize separating spacers, care must be exercised to use wheels specially manufactured for that purpose. (29 CFR 1910.215(d)(6))

4.2.5.1.10. Start Up Procedures. Do not operate machines until the safety guards are in place. After the guards are reinstalled, rotate the wheel several revolutions by hand to ensure it clears both the work rest and the safety guards. Defective wheels are most likely to break when first started; therefore, run newly installed wheels at full operating speed for at least 1 minute before work is applied. During this time, ensure the operator and other personnel stand clear of the machine. (ANSI B 7.1)

4.2.5.2. Wheel Dressing. Damaged or out-of-balance abrasive wheels will produce poor work and may injure the operator. To restore a rutted, excessively rough, or unbalanced wheel, it is necessary to dress it by removing part of the face. Wheel dressing tools will be equipped with hood guards over the tops of cutters to protect the operator from flying wheel particles or pieces of broken cutters. The dresser will be supported on the work rest and the work rest will be adjusted

away from the wheel so the heel of the dresser may hook over the work rest and be guided by it as the dresser is moved evenly back and forth across the wheel face. Dressing will be done only by personnel trained in this task. Operators performing dressing operations will:

4.2.5.2.1. Wear a face shield over safety glasses for face protection and a respirator if conditions warrant.

4.2.5.2.2. Use a dressing tool with a cutting head equal in width to the width of the grinding wheel. Recommend selecting a dresser containing self-traversing star wheels in the cutting head requiring the operator to simply place the dresser against the wheel and apply pressure. The work rest is not required as a guide in order to properly dress the wheel utilizing this dressing tool.

4.2.5.2.3. Inspect star dressers for loose shaft and worn discs prior to use.

4.2.5.2.4. Round off wheel edges with a hand stone before and after dressing to prevent the edges from chipping.

4.2.5.2.5. Use a work rest to support and guide the tool. Use a tool holder if one is available.

4.2.5.2.6. Apply moderate pressure slowly and evenly.

4.2.5.2.7. Always apply diamond dressers at the center or slightly below the center of the wheel.

4.2.5.3. Lubrication. Grinding machine spindle bearings shall be properly lubricated to prevent overheating or other conditions that might damage the abrasive wheel. Lubrication intervals will be established based on the manufacturer's recommendations or more stringent criteria may be adopted if usage experience requires. Improperly lubricated spindle bearings will cause the mounting spindle to expand because of heat generated, thus exerting a stress in the arbor hole area. Other adverse conditions related to improper lubrication can cause vibration that may result in a broken wheel. (ANSI B7.1)

4.2.6. Guarding. Guards shall be used on grinding machines except wheels used for internal work where the work offers protection. Types 16, 17, 18, 18R, and 19 cones, plugs, and threaded hole pot balls are examples of those not requiring guards while used for internal work (**Figure 4.2.**). On other wheels the guard shall cover the spindle end, nut, and flange projections, and it shall be mounted to maintain proper alignment with the wheel. Fasteners used to mount the guard shall equal or exceed the strength of the guard. An exception to this is where the work itself provides adequate protection. The maximum exposure angles specified in the following paragraphs shall not be exceeded. Visors or other accessory equipment shall not be included as a part of the guard when measuring the guard opening, unless such equipment offers the same protection as the guard and unless the accessory equipment is fastened as securely as the guard. (29 CFR 1910.215(a)(1), .215(a)(2), and .215(b)(2))

4.2.6.1. Bench and Floor Stand (Pedestal) Grinders. The angular exposure of the grinding wheel periphery and sides for safety guards used on these machines shall not exceed 90 degrees or one-fourth of the periphery. This exposure shall begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle. Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure shall not exceed 125 degrees (29 CFR 1910.215(b)(3)) (**Figure 4.3.** and **Figure 4.4.**). Where the operator stands in front of the opening, these units shall be equipped with a peripheral protector (tongue guard) that can be

adjusted to the decreasing diameter of the wheel. The opening will be maintained at no more than one-fourth of an inch. (29 CFR 1910.215(b)(9))

4.2.6.2. Cylindrical Grinders. The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on cylindrical grinding machines shall not exceed 180 degrees. This exposure shall begin at a point not more than 65 degrees above the horizontal plane of the wheel spindle (**Figure 4.5.**). Tongue guard protective requirements of paragraph **4.2.6.** also apply to cylindrical grinders. (29 CFR 1910.215(b)(4) and (9))

4.2.6.3. Top Grinding Operations. Where the work is applied to the wheel above the horizontal centerline, the exposure of the grinding wheel periphery shall be as small as possible and shall not exceed 60 degrees (figure 4.6.). (29 CFR 1910.215(b)(8))

4.2.6.4. Additional Types of Grinders. The equipment itemized in the following paragraphs has minimal use at most Air Force installations and guarding criteria will not be addressed. Organizations using this equipment shall develop criteria using the OSHA references listed.

4.2.6.4.1. Cup wheels - 29 CFR 1910.215(b)(1).

4.2.6.4.2. Surface grinders and cutting-off machines - 29 CFR 1910.215(b)(5).

4.2.6.4.3. Swing frame grinders - 29 CFR 1910.215(b)(6).

4.2.6.4.4. Automatic snagging machines - 29 CFR 1910.215(b)(7).

4.2.6.4.5. Band-type guards - 29 CFR 1910.215(b)(11).

4.2.6.5. Guard Material and Design. If guards are locally manufactured they will meet the requirements of 29 CFR 1910.215(b)(10).

4.2.6.6. Shields. Shatter-resistant transparent shields should be provided as an added margin of safety on grinding machines.

4.2.6.7. Power Transmission. When power transmission apparatus is separate from the grinding machine, refer to Chapter 3 for guarding requirements.

4.2.7. Wet Grinding. Machines will meet the same criteria for guarding, work rests, and machine set up as for other abrasive wheel machinery. The following also apply:

4.2.7.1. When shutting down a wet grinding operation, the coolant will be shut off first and the wheel allowed to rotate until the coolant has been spun out.

4.2.7.2. Wet process grinding wheels will not be left partially submerged in water because this may cause an unbalanced wheel that may break when rotated.

4.2.7.3. The concentration and alkalinity of coolant affects organic bonded wheels. To avoid damage to these wheels, it is important to follow the manufacturer’s directions.

4.2.7.4. Floor surfaces around wet processes will be of rough concrete or will have nonskid materials or mats applied to reduce slipping hazards.

4.2.8. Wheel Storage. Abrasive wheels are easily broken; therefore, care shall be exercised in handling and storage to prevent damage.

4.2.8.1. Wheels will be stored in a dry area that is not subject to extreme temperature changes, or below freezing temperatures. Wet wheels may crack or break if stored below 32 degrees Fahren-

heit. Breakage may also occur if a wheel or disk is taken from a cold storage room and work is applied to it before it is warmed to room temperature.

4.2.8.2. Storage will be arranged to allow wheel selection and removal without damaging other wheels.

4.2.8.3. Thin organic bonded cutting wheels will be laid on a flat horizontal surface away from heat.

4.2.8.4. Straight or tapered wheels are best stored when supported on edge in racks.

4.2.8.5. Wheels will be dated when placed in storage so they can be issued oldest first. Manufacturer's instructions will be checked to see if wheels or discs have a shelf life requirement and to see if they have special handling or storage requirements that could affect their safe use.

4.2.8.6. Wheels that cannot be hand carried will be moved by hand trucks or powered trucks. Wheels will not be rolled on the floor. When moving wheels by truck, workers will avoid bumps and irregular surfaces.

4.2.8.7. Wheel storage areas should be as close to the grinding operation as practical.

4.2.8.8. Wheels that are bumped, dropped, or show evidence of abuse will be inspected using procedures in paragraph 4.2.5. prior to being placed in storage. Those found unsatisfactory will be tagged and discarded unless repairs can be performed.

4.2.9. Polishing and Buffing Wheels:

4.2.9.1. The softness of these wheels is controlled by the size of the flange. The larger the flange, the harder the surface. Special wheel dressing tools may also be used to soften the surface.

4.2.9.2. When polishing and buffing wheels are driven by variable speed motors, speed controls should be safeguarded from accidental change.

4.2.9.3. When rouge or tripoli is applied to a rotating wheel, the side of the cake will be held lightly against the wheel's periphery. If a stick is used, the side of the stick will be applied so that it will fly away from the wheel.

4.2.9.4. Tool rests are not required for wire buffers and polishers.

4.2.10. Special Grinding Operations. The use of materials such as magnesium, titanium, thorium, and beryllium present fire and health hazards. Supervisors of these operations will contact the installation ground safety, fire department, and BE personnel for assistance in determining safe work practices and protective equipment needs.

Figure 4.1. Flange Installation.

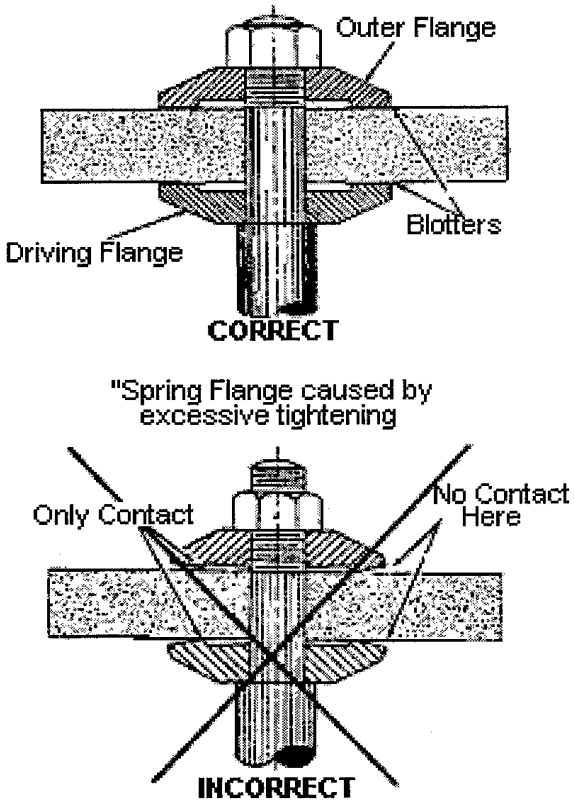


Figure 4.2. Types 16, 17, 18, 18R, and 19 Cone and Plug Wheels.

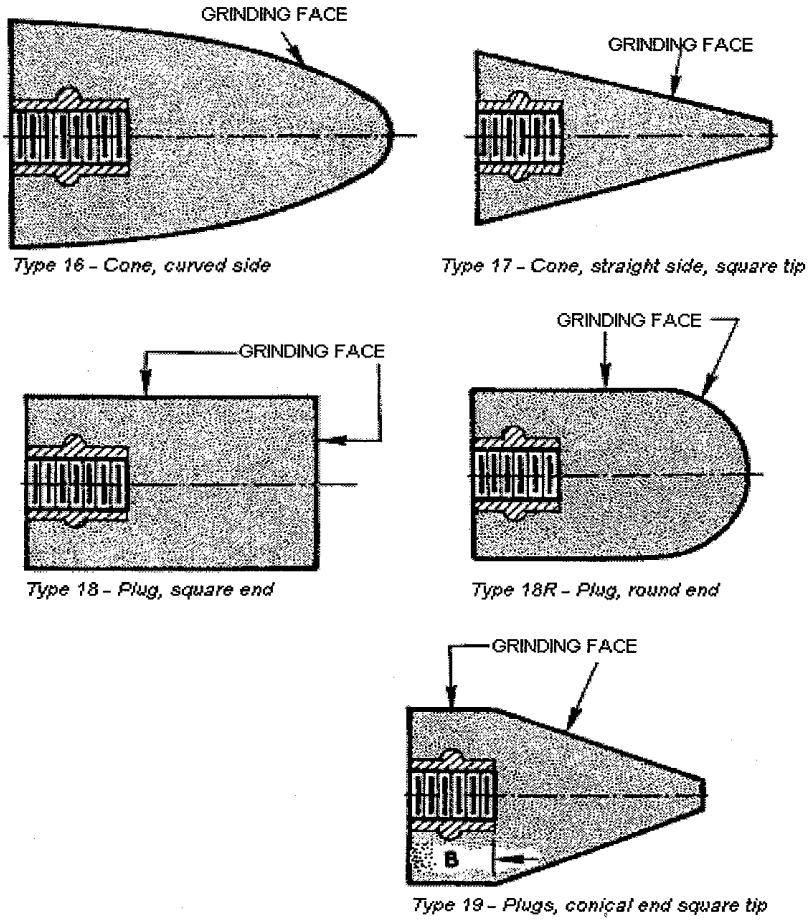


Figure 4.3. Bench and Floor Stand Grinder Guard Exposure Angles.

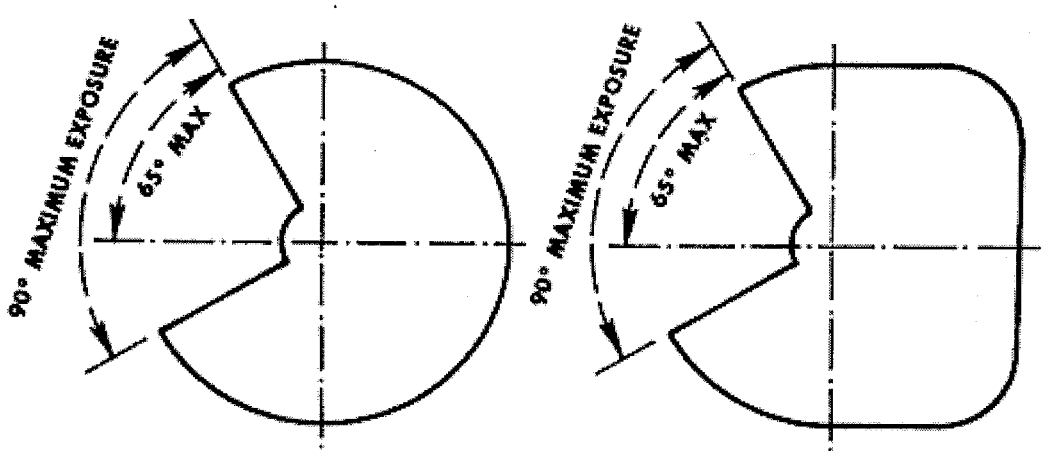


Figure 4.4. Bench and Floor Stand Grinder Guard Exposure Angles When Contact Below the Horizontal Plane of the Spindle is Required.

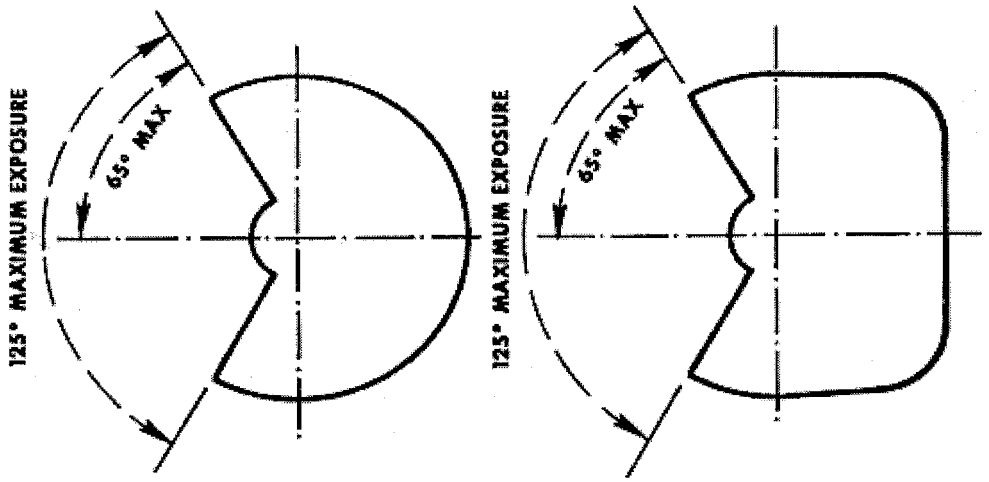


Figure 4.5. Cylindrical Grinder Guard Exposure Angles.

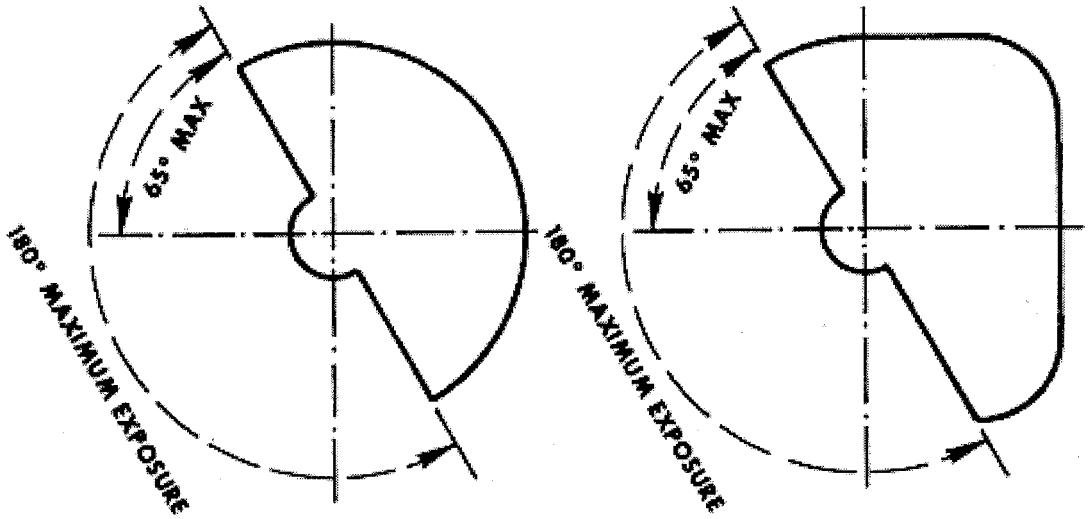
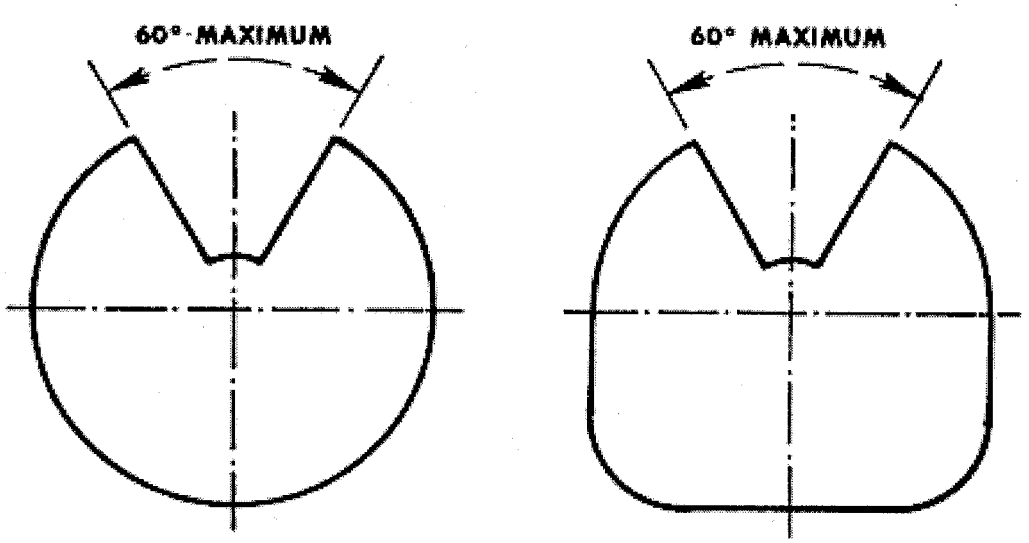


Figure 4.6. Top Grinding Guard Exposure Angles.



FRANCIS C. GIDEON, Maj Gen, USAF
Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

Air Force Instruction (AFI) 91-301, *Air Force Occupational and Environmental Safety, Fire Protection, and Health (AFOSH) Program.*

Air Force Occupational Safety and Health (AFOSH) Standard 48-2, *Industrial Ventilation* (formerly designated as AFOSH Standard 161-2).

AFOSH Standard 91-22, *Walking Surfaces, Guarding Floor and Wall Openings and Holes, Fixed Industrial Stairs, and Portable and Fixed Ladders* (formerly designated as AFOSH Standard 127-22).

AFOSH Standard 91-31, *Personal Protective Equipment.*

AFOSH Standard 91-45, *Hazardous Energy Control and Mishap Prevention Signs and Tags* (formerly designated as AFOSH Standard 127-45).

American National Standards Institute (ANSI) 01.1, *Safety Requirements for Woodworking Machinery.*

ANSI B7.1, *Safety Requirements for the Use, Care, and Protection of Abrasive Wheels.*

ANSI B11.1, *Mechanical Power Presses.*

ANSI B11.3, *Power Press Brakes.*

ANSI B11.4, *Shears.*

ANSI B11.6, Safety *Requirements for the Construction, Care, and Use of Lathes.*

ANSI B11.7, *Cold Headers and Cold Formers.*

ANSI B11.8, *Safety Requirements for the Construction, Care, and Use of Drilling, Milling, and Boring Machines.*

ANSI B11.10, *Metal Sawing Machines.*

ANSI B11.13, *Single- and Multiple Spindle Automatic Screw/Bar and Chucking Machines.*

ANSI B11.15, *Safety Requirements for Construction, Care, and Use of Pipe, Tube, and Shape Bending Machines.*

National Safety Council (NSC) *Accident Prevention Manual for Industrial Operations, Engineering and Technology.*

Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.94, *Ventilation.*

OSHA 29 CFR 1910.147, *The Control of Hazardous Energy (Lockout/Tagout).*

OSHA 29 CFR 1910, Subpart O, *Machinery and Machine Guarding.*

OSHA 29 CFR 1910.211, *Definitions.*

OSHA 29 CFR 1910.212, *General Requirements for all Machines.*

OSHA 29 CFR 1910.213, *Woodworking Machinery Requirements.*

OSHA 29 CFR 1910.215, *Abrasive Wheel Machinery.*

OSHA 29 CFR 1910.217, *Mechanical Power Presses.*

OSHA 29 CFR 1910.219, *Mechanical Power-Transmission Apparatus.*

Technical Order (TO) 34-1-3, *Inspection and Maintenance of Machinery and Shop Equipment.*

Abbreviations and Acronyms

AFI—Air Force Instruction

AFOSH—Air Force Occupational Safety and Health

AFSC—Air Force Safety Center

ANSI—American National Standards Institute

BE—Bioenvironmental Engineering

BEE—Bioenvironmental Engineer

CFR—Code of Federal Regulations

DRU—Direct Reporting Unit

FOA—Field Operating Agency

HQ—Headquarters

MAJCOM—Major Command

Mil Spec—Military Specification

NEC—National Electrical Code

NSC—National Safety Council

OSHA—Occupational Safety and Health Administration

PDO—Publishing Distribution Office

PPE—Personal Protective Equipment

Psi—Pounds Per Square Inch

Rpm—revolutions per minute

TO—Technical Order

US—United States

WWW—World-Wide Web

Terms

Abrasive Wheel—A cutting tool made of abrasive grains held together by organic or inorganic bonding materials.

Anti-Repeat or One Stroke Only—A system or device that may be part of the clutch and (or) brake control mechanism and limits the press to a single stroke when the tripping control is held in an

operational position.

Chuck—A revolving clamp-like device used for gripping and driving stock or tools.

Clutch—A device used to connect and disconnect a driving and driven part of a mechanism that, when connected, transmits rotary motion from the driving to the driven member.

Coolant—Oil or other fluid that is applied to the workpiece and tools to dissipate the heat from cutting operations.

Die—Tooling used in a press for cutting or forming material. Upper and lower dies make a complete set.

Dog—A device for gripping or holding material or a machine component in place.

Feather Board—An angular board with multiple parallel saw cuts that is used as a side and top holddown to prevent kickbacks and keep hands away from moving blades and cutters.

Filler Piece—A narrow strip of wood with cleats on both ends that permits ripping of narrow material on circular saws without removal of guard.

Flange—A collar, disk, or plate used to hold an abrasive wheel in position on a rotating shaft.

Inch—An intermittent motion of a mechanism by momentary operation of the inch control. Operation of the inch control intermittently engages the drive clutch so that a small portion of one stroke or indefinite stroking can occur depending upon the length of time the control is operated.

In-Running Nip Point—A hazardous condition created by moving or rotating objects that move toward each other.

Interlock—A device that prevents operation of the control that starts a machine in motion until a condition is met, such as the guard being in place.

Kickback—The tendency of blades and cutters to force material being milled up and back toward the operator.

May—Indicates an acceptable or satisfactory method of accomplishment.

Periphery—The outer circumference of the wheel.

Peripheral Guard—Commonly referred to as a tongue guard. This adjustable guard is installed on machines where the operator is in front of the grounding surface during the operation.

Pinch Point—Any point other than the point of operation where it is possible for a part of a person's body or clothing to be caught between moving parts.

Point of Operation—The areas of a machine where cutting, shearing, forming, assembling, etc., takes place.

Power Transmission Apparatus—Machinery components, including gears, cams, shafts, pulleys, belts, and rods, which transmit energy and motion from the source of power to the point of operation.

Push Block—A block of wood having a handle and shoulder at the rear end that is used for pushing short lengths of material over revolving cutters.

Push Stick—A strip of wood with a notch cut into one end that is used to push short lengths of material through saws.

Shall—Indicates a mandatory requirement.

Shear Point—The immediate area where two or more machine elements are in close contact, creating a shearing action.

Shelf Life—Period of time that an abrasive wheel can be stored and safely returned to service.

Should—Indicates a preferred method of accomplishment.

Snagging—Grinding which removes relatively large amounts of material without regard to close tolerances or surface finish requirements.

Spindle—A rotating or fixed shaft-like member mounted in bearings and connected to the drive mechanism. A device for holding the work piece or a cutting tool is mounted on one or both ends.

Spreader—A curved piece of steel mounted behind a saw blade that prevents internal stresses within wood from clamping down on the saw blade.

Tail Stock t—he adjustable or sliding heads of lathes.

Tongue Guard—Same as peripheral guard.

Wheels—:

Buffing—A wheel made of disks of felt, linen, or canvas . The cutting surface is coated with rouge, tripoli, or other mildly abrasive substances.

Inorganic—A wheel bonded by inorganic material such as clay, glass, porcelain, sodium silicate, magnesium oxychloride, or metal. Those bonded with ceramic materials are referred to as a *vitrified bonded wheel*.

Organic—A wheel bonded by an organic material such as resin, rubber, shellac, or other similar bonding agent.

Polishing—A wheel made of wood covered with leather or disks of canvas or similar material stitched together with a coat of emery or other abrasive glued to the wheel.

Reinforced—A type of organic wheel that has webbing, fabric, or filament that provides resistance to complete breakage if the wheel becomes cracked or damaged.

Will—Is also used to indicate a mandatory requirement and in addition is used to express a declaration of intent, probability, or determination.

Wire Brush—A wheel made of varying protruding wires of different thickness, all attached to a central core.

Attachment 2

WOODWORKING MACHINERY CHECKLIST

This is not an all-inclusive checklist. It simply highlights some critical items in this standard. Other requirements exist in the standard that are not included in the checklist. Where approariate, MAJCOMs, DRUs, FOAs, local safety personnel, and supervisors will add to this checklist to include command or individual shop-unique requirements or situations.

A2.1. Tilting-Arbor and Tilting-Table Saws: (paragraph 2.2.1.)

A2.1.1. Is the table saw equipped with a hood that covers the blade-and automatically adjusts itself to the thickness of the material upon which it rides?

A2.1.2. Does the hood cover the part of the saw blade exposed above the material?

A2.1.3. Is the hood adaptable to cover tilted blades?

A2.1.4. Is a spreader provided at the table saw to prevent the wood's internal stresses from clamping down on the saw blade?

A2.1.5. Are table throat openings kept as small as possible to prevent material from dropping below the level of the table?

A2.1.6. Are several size throat pieces available to accommodate rabbeting, grooving, and dadoing operations?

A2.1.7. Are antikickback dogs and fingers or safety hold-down wheels installed when material is being ripped?

A2.1.8. Are antikickback dogs and fingers inspected before each use?

A2.1.9. Are antikickback dogs and fingers kept sharp to maintain their holding power?

A2.1.10. Is a helper positioned at the output end of the saw whenever it appears it might be necessary to reach over a revolving saw blade?

A2.1.11. Are saw blades allowed to come to a stop on their own rather than by thrusting a piece of wood against the cutting edge or side of the blade?

A2.1.12. Do saw tables extend far enough on either side of a machine to give full support to a length of board that may be cut?

A2.1.13. Is the blade or cutting head inspected for proper cutting condition (e.g., teeth sharp and properly set, no cracks, free of foreign residue) before a job is started?

A2.1.14. Is the correct blade matched to the work being done?

A2.1.15. Are the following precautions taken:

A2.1.15.1. A crosscut blade is never used for rip sawing?

A2.1.15.2. A ripping blade is never used for crosscutting?

A2.1.15.3. Do Services hobby shop supervisors label each saw with a sign or decal that states which type blade is installed and what it is to be used for?

A2.1.15.4. Are special blades used for materials in which there may be nails or other metal (example: plywood or lumber)?

A2.1.15.5. Is a carbide-tipped, controlled-cut blade used when warped, twisted-grain, knotty, or frozen lumber is ripped?

A2.1.16. Do operators take care that they do not crowd (force material faster than it can be cut) the saw?

A2.1.17. If the saw does not cut a clean, straight line, is the saw or running speed checked and condition remedied?

A2.1.18. Do operators only adjust the rip fence after the saw has been turned off and the blade rotation has stopped?

A2.1.19. Is a permanent line marked on the table in front of and in line with the saw blade to enable the operator to set the rip fence without lifting the saw guard?

A2.1.20. Are hands kept out of the line of cut when feeding saws?

A2.1.21. Is material moved forward with a push stick when there is not enough room for hand movement between the rip fence and saw blades?

A2.1.22. Is the hood left in place when narrow material is ripped?

A2.1.23. Are saw blades only set high enough to cut through the material being worked?

A2.1.24. Is one of the following practices used to ensure the above?

A2.1.24.1. No more than three teeth protrude above the material being cut, or

A2.1.24.2. No more than one-eighth of an inch of saw blade protrudes above the material being cut.

A2.1.25. Are feather boards used as side guides and top holddowns on operations (rabbeting, grooving, and dadoing) when a blade hood cannot be used?

A2.2. Radial Arm Saws: (paragraph 2.2.2.)

A2.2.1. Are radial saws equipped with a hood that encloses a saw blade and the arbor ends?

A2.2.2. Is the lower section of the hood hinged so it rises and falls, adjusting itself automatically to the thickness of the material as the saw passes through it?

A2.2.3. Are antikickback devices or hold-down wheels installed on saws used for ripping?

A2.2.4. Does the device adapt to any thickness of stock to be cut?

A2.2.5. Are manually-operated radial saws installed so the front end of the table is slightly higher than the rear so the cutting head does not move forward when the motor is turned on?

A2.2.6. Prior to starting the saw does the operator pull the saw cutting head all the way forward and, with the operator's hand on the pull grip and exerting little or no force, follow the head back to the original noncutting position?

A2.2.7. Is the unit turned off and the rollers checked for wear if the saw has a tendency to drag, is jerky, or requires excessive force?

A2.2.8. Does the operator turn the saw on and check to see that the cutting head does not move forward?

A2.2.9. Is the unit taken out of service and the malfunction corrected any time sluggish or hesitant movement of the saw is detected?

A2.2.10. Do operators take the unit out of service if at any time the saw rolls or moves as a result of vibration?

A2.2.11. Does the saw have a positive limit-stop to prevent the saw from traveling beyond the front edge of the table?

A2.2.12. Is material measured by placing the material to be cut against a stop gauge (whenever repeat cuts are necessary)?

A2.2.13. If it is necessary to measure with a ruler, is the material kept well away from the saw until measuring is completed?

A2.2.14. Is the saw head rotated 90 degrees right or left and clamped in position when ripping with a radial saw is necessary?

A2.2.15. Is the material fed against the revolving blade from the side where the blade rotates upward toward the operator?

A2.2.16. Do the teeth of the saw extend slightly through the material being cut?

A2.2.17. Is the direction of the saw rotation conspicuously marked on the hood?

A2.2.18. Is a permanent decal or sign not less than 1 inch by three-fourths of an inch, reading **"CAUTION: NEVER RIP FROM THIS END"** (or the nearest commercially available equivalent) affixed to the rear of the guard at approximately the level of the arbor?

A2.2.19. Is the saw allowed to return to its stopped position before the stock is removed from the table?

A2.2.20. Is the locking device on the saw head securely fastened when angle or miter cuts are being made?

A2.2.21. Does the stock lie solidly on the table when cross-cutting?

A2.2.22. Does the operator ensure that the blade being used is the proper one for the work being performed?

A2.2.23. When removing short pieces from a table close to a saw blade, does the operator ease the saw back to the idling position and make sure that all bouncing has stopped before placing hands on the table?

A2.2.24. Is cylindrical stock securely clamped before being cut on a radial saw?

A2.3. Band Saws: (paragraph 2.2.3.)

A2.3.1. Are both upper and lower wheels completely enclosed on both sides of band saws?

A2.3.2. Are these enclosures capable of being easily removed to permit saw blade maintenance?

A2.3.3. Is the working part of a saw blade (between the guide rolls and upper wheel enclosure) guarded to prevent accidental contact with the saw blade?

A2.3.4. Is the guard self-adjusting and attached to the gauge so that (in any position of the gauge) the guard will completely cover the portion of the saw blade between the guide rolls and the upper wheel enclosure?

A2.3.5. Is the saw equipped with an automatic tension control?

A2.3.6. Does the feed roll on a self-fed handsaw have a guard to prevent the operator's hands from coming into contact with the in-running rolls at any point?

A2.3.7. Is the saw always operated within the safe limit recommended by the manufacturer?

A2.3.8. If material binds or pinches on the blade, is the machine turned off and blade motion allowed to stop before the operator attempts to back the work away from the blade?

A2.3.9. If a saw blade breaks, does the operator shut off the power, lock the start switch in the off position and not attempt to remove any part of the saw blade until the machine has completely stopped?

A2.4. Jointers: (paragraph 2.2.4.)

A2.4.1. Is each hand-fed planer and jointer (with a horizontal or vertical head) equipped with a cylindrical cutting head?

A2.4.2. Does the knife on these machines project only one-eighth of an inch beyond the cylindrical body of the head?

A2.4.3. Is the opening in the table kept as small as possible?

A2.4.4. Is the clearance between the edge of the rear table and the cutting head circle or knives no more than one-eighth of an inch?

A2.4.5. Is the table throat opening no more than 2 inches when tables are set or aligned with each other for a zero cut?

A2.4.6. Are jointers with front-table-mounted fences equipped with an adjustable device to prevent thin stock from slipping laterally under the portion of the fence at the rear of the table?

A2.4.7. Is an automatic guard provided to cover the section of the cutter head near the operator (on the working side of the fence) and to contact the wood to prevent any opening from remaining between the guard and wood during the operation?

A2.4.8. Does the guard cover the section of the cutter head on the nonworking side of the fence?

A2.4.9. Does the guard over the section of the cutting head on the rear side of the fence consist of a sliding metal shield that automatically adjusts to the exposed length of the cutter head?

A2.4.10. When power feeders are used, does a metal shield or hood guard the feeding mechanism?

A2.4.11. Do operators use holddown push blocks, jigs, or fixtures?

A2.5. Power Feed Planers: (paragraph 2.2.5.)

A2.5.1. Are guards provided for feed rolls, cutting heads and holddown rolls at the discharge end of power feed planers?

A2.5.2. Are feed rolls guarded by a metal strip in front of the rolls under which material may pass, but will prevent an operator's fingers from being drawn into the machine?

A2.5.3. If the top roll is corrugated, does the strip extend over the top of the roll?

A2.5.4. Are cutting heads and discharge rolls guarded by a solid metal enclosure of substantial construction?

A2.5.5. When other than corrugated top feeders are used, is an antikickback device installed?

A2.5.6. Does the operator examine each planer before using it to ensure that knives are not set to take too heavy a cut for one pass?

A2.5.7. Do helpers position themselves where they will not be pinned between the material and an immovable object?

A2.5.8. Do operators take precautions to keep their fingers from being pinched between the table top and the material if the material is tipped quickly up and down by the infeed rolls?

A2.6. Shapers: (paragraph 2.2.6.)

A2.6.1. Are shapers equipped with a braking device that will bring the cutting head to a stop within 10 seconds after power is shut off?

A2.6.2. Is a double-spindle machine equipped with separate braking devices?

A2.6.3. Does the fence have as small an opening for knives as possible?

A2.6.4. Does the fence extend at least 18 inches on either side of the spindle?

A2.6.5. Does a guard enclose cutting heads? Is this guard less than the greatest diameter of the cutter?

A2.6.6. Are holddowns and jigs used to limit exposure of hands to cutters, whenever possible?

A2.6.7. When a blade is removed from a spindle, are all other blades removed at the same time?

A2.7. Lathes: (paragraph 2.2.7.)

A2.7.1. Is a hinged metal shield or hood (that completely covers the knives and material when the machine is in operation) provided on rotating, cutter-type lathes?

A2.7.2. Is a brake (that will bring the rotating material to a quick, but not instantaneous stop after the power is shut off) installed on automatic lathes?

A2.7.3. Are automatic lathes placed with the back side against a wall or barrier that will contain knives if they are thrown rearwards?

A2.7.4. Are tool rests set parallel and as close as possible to the work and high enough so the tools butt into the wood slightly above the horizontal center of the piece being turned?

A2.7.5. Is a control stop provided on faceplate-type lathes?

A2.7.6. Are guards that will contain the workpiece if it separates from its anchorage installed on lathes used for turning long pieces of material?

A2.7.7. Do operators stand to the side when working with hand-turning tools?

A2.7.8. Is sandpaper held in the fingers and pressed lightly against a small area at the top of the rotating material?

A2.7.9. Is only good quality wood used for wood turning?

A2.8. Sanding Machines: (paragraph 2.2.8.)

A2.8.1. Is a guard installed on the feed rolls of self-feed sanding machines?

A2.8.2. Are guards installed at each nip point on a belt sanding machine? Is the unused run of the sanding belt guarded?

A2.9. Boring and Mortising Machines: (paragraph 2.2.9.)

A2.9.1. Are set screws on safety-bit chucks non-projecting?

A2.9.2. Is a guard, enclosing all portions of the bit and chuck above the material being worked, installed on boring bits?

A2.9.3. Is the top of the driving mechanism enclosed?

A2.9.4. If there is a counterweight, is one of the following (or equivalent) methods used to prevent its dropping?

A2.9.4.1. Bolted to the bar by a bolt passing through both the bar and counterweight;

A2.9.4.2. A bolt put through the extreme end of the bar;

A2.9.4.3. A safety chain attached if the counterweight does not encircle the bar.

A2.9.4.4. Are other types of counterweights suspended by chain or wire rope and travel in a pipe or other suitable enclosure whenever they might fall and cause injury or damage?

A2.9.5. Are universal joints on spindles of boring machines completely enclosed?

A2.9.6. Are holddown devices installed on table-type boring or mortising machines?

A2.10. Tenoning Machines: (paragraph 2.2.10.)

A2.10.1. Are feed chains and sprockets of double end tenoning machines completely enclosed (except for the portion of cabin used for conveying the stock)?

A2.10.2. Are sprockets and chains guarded at the sides by plates projecting beyond the periphery of sprockets and the ends of lugs at the rear ends of frames over which feed conveyors run?

A2.10.3. Are cutting heads and saws (if used) on tenoning machines covered by metal guards? Do these guards cover at least the unused part of the periphery of the cutting head?

A2.10.4. If an exhaust system is used, does the guard form part or all of the exhaust hood?

A2.11. Electrical Requirements and Safeguards: (paragraph 2.2.11.)

A2.11.1. Is the motor **START** switch protected against accidental or inadvertent operation?

A2.11.2. Is machinery installed according to the National Electrical Code (NEC)?

A2.11.3. Are control switches available to workers at their operating positions so they do not need to reach over moving parts of machinery?

A2.11.4. Is the stop control switch identified by a printed word or color coded red?

A2.11.5. Do operators know that controls are not to be wedged for continuous operation?

A2.11.6. Are undervoltage protective devices installed on machines that are not adequately safeguarded to protect the worker during undervoltage situations?

A2.11.7. Have installation safety offices and shop supervisors identified those machines that require undervoltage protection?

A2.11.8. Are foot treadle controls protected against unexpected or accidental tripping? Do these controls have a nonslip surface?

A2.11.9. Are exposed noncurrent-carrying metal components (that may become energized) grounded?

A2.11.10. Are all machine energy sources or energy isolating devices, such as disconnect switches or circuit breakers, locked out or tagged out before maintenance is performed or major adjustments are made with guards and panels removed? Is a machine or equipment with a simple wall plug as the power source unplugged?

A2.11.11. Is an AF Form 982, *Do Not Start* tag, used temporarily until lockout is accomplished or in conjunction with the lockout? (Also AFOSH Standard 91-45)

A2.12. Safeguarding by Location or Distance: (paragraph 2.2.12.)

A2.12.1. Is the machine or its dangerous moving parts positioned so hazardous areas are not accessible or do not present a hazard to a worker during the normal operation of the machine?

A2.12.2. Before attempting the use of any safeguarding techniques, is a thorough hazard analysis made of each machine and particular situation?

A2.12.3. Does the supervisor and installation safety office perform this analysis and publish the results?

A2.12.4. Does the analysis clearly identify that workers are protected from dangerous moving parts and is one of the following restrictions used?

A2.12.4.1. Unguarded moving parts of machines are a minimum distance of 8 feet above the work level (floor, platform, or passageway), or

A2.12.4.2. Machines are in an enclosed area with a locked entrance and the enclosure (wall or fence) is at least 8 feet high. Is the main source of power disconnected and locked in the **OFF** position when maintenance, service, or machine adjustments are made?

A2.13. Safeguarding Devices: (paragraph 2.2.13.)

A2.13.1. If a safeguarding device is used to replace a guard, does it perform one or more of the following functions:

A2.13.1.1. Stop the machine if a body part is inadvertently placed in the danger area?

A2.13.1.2. Restrain or withdraw the operator’s hands from the danger area during operation?

A2.13.1.3. Require the operator to use both hands on machine controls?

A2.13.1.4. Provide a barrier that is synchronized with the operating cycle of the machine?

A2.13.2. Are safeguarding devices installed, adjusted, and used according to manufacturer's operating and maintenance instructions?

A2.14. Safeguarding by Barrier or Enclosure: (paragraph 2.2.14.)

A2.14.1. Are hazardous parts, which are not protected by the device, guarded according to paragraph 2.2.14.?

A2.14.2. Does the guard, by design, construction, application, and adjustment:

A2.14.2.1. Prevent hands, fingers, or other body parts from entering into the hazardous areas by reaching through, over, under, or around the guard?

A2.14.2.2. Not create a pinch point between the guard and moving machine parts?

A2.14.2.3. Be not easily removed by the worker?

A2.14.2.4. Offer maximum visibility of the point of operation consistent with operational or maintenance requirement?

A2.14.3. Is the guard securely affixed to the machine?

A2.14.4. When a point-of-operation guard cannot be used because of unusual shapes or cuts, are jigs or fixtures used?

A2.14.5. Whenever a guard is removed for other than an operational requirement, is the machine shut down and the control switch(s) locked and tagged in the **OFF** position?

A2.14.6. Are enclosure and barrier guards interlocked with the machine control (whenever possible) so the machine cannot be activated unless the guard itself or the hinged or movable sections of the guard are in position?

A2.14.7. Does the guard prevent the operator from opening the interlocked section and reaching into the point of operation?

A2.14.8. Do guards, which are interlocked with the machine cycle, stop the related component, interrupt the machine cycle, or shut down the machine?

A2.14.9. When the periphery of the blades of a fan are less than 7 feet above the floor or working level, are the blades guarded?

A2.14.10. Does the fan guard have openings no larger than one-half of an inch in width and depth?

A2.14.11. Is the mesh able to withstand being pushed into the fan blade during normal use?

A2.14.12. Is the guard designed and installed so no part of the body can be inadvertently placed in, on, under, or over the edges of the guard where it might contact a moving part?

A2.14.13. Are guards made of expanded metal; perforated or solid sheet metal; or wire mesh, plastic, or other material of equal or greater strength?

A2.14.14. Are guards fastened to the framework of the machinery?

A2.14.15. Does the installation civil engineer, installation ground safety officer, or the installation BEE determine the best material for guard construction (if required) in environments where chemical or corrosive operations are performed?

A2.14.16. Is the enclosure guard and its supports designed and installed so an adult person leaning on, or falling against, the enclosure will not receive an injury from the moving part?

A2.14.17. Is the enclosure capable of containing the broken parts (if there is a reasonable possibility of the moving part failing and causing injury)?

A2.14.18. When part failure is considered a hazard, is the guard filler material a solid metallic sheet, plate stock, or casting?

A2.14.19. If sheet or molded plastics or other metallics are used, have they been impact-tested to resist penetration of a specific failing part?

A2.14.20. Do openings to permit lubrication, adjustment, or inspection have hinged, sliding, or bolted cover plates and are they closed prior to starting the machine?

A2.14.21. Are horizontal belts and ropes above floors or platforms guarded for their entire length if located over passageways or workplaces, if center-to-center distance between pulleys is 10 feet or more, or if the belt is 8 inches or more in width?

A2.14.22. Are vertical belts running over a lower pulley above the floor or platform guarded at the bottom in the same manner as overhead belts?

A2.14.23. Where loose pulleys or idlers are not practical, are belt perches (brackets, rollers, etc.) used to keep idler belts away from the shafts? Are these perches of strong materials and designed for the safe shifting of belts?

A2.14.24. When the belt or rope is in motion, is belt dressing applied (only when necessary) where belts leave the pulleys, not where they approach them?

A2.14.25. Is a guard provided to prevent the belt from leaving the pulley on the side where insufficient clearance exists, unless the distance to the nearest fixed pulley, clutch, or hanger exceeds the width of the belt used?

A2.14.26. Where there are overhanging pulleys on a line, jack, or countershaft, with no bearing between the pulley and the outer end of the shaft, is a guard installed to prevent the belt from running off the pulley?

A2.14.27. Are pulleys with cracks or pieces broken out of the rims taken out of service?

A2.14.28. Are pulleys that are used in areas where they would be exposed to corrosion made of corrosion-resistant material?

A2.14.29. Are pulleys located in corrosive environments inspected semiannually to ensure they are in satisfactory condition?

A2.14.30. Do operators and maintenance personnel pay close attention to the integrity of guards?

A2.14.31. If exhaust hoods serve as guards for table saws or wheels of bandsaws do they meet the construction criteria for guards?

A2.15. Related Equipment: (paragraph 2.2.15.)

A2.15.1. Are holding tools used when it would otherwise be necessary to place hands in the danger zone?

A2.15.2. Are these tools used only to supplement guard protection and not used as a substitute for guarding?

Attachment 3

METAL-WORKING MACHINERY CHECKLIST

This is not an all-inclusive checklist. It simply highlights some critical items in this chapter. Other requirements exist in the chapter that are not included in the checklist. Where approariate, MAJCOMs, FOAs, DRUs, local safety offices, and supervisors will add to this checklist to include command or individual shop-unique requirements or situations.

A3.1. Power Presses: (paragraph 3.2.1.)

A3.1.1. Does the supervisor ensure that either a fixed barrier guard, safeguard device, or combination of both is installed and used on every operation when the opening between the die (tool) and base (anvil) is more than one-fourth of an inch?

A3.1.2. Do the functional manager and installation safety officials approve guarding by location?

A3.1.3. Do personnel know that the use of hand-feeding tools, regardless of size, does not replace a guard or device?

A3.1.4. Are guards designed and constructed so a worker cannot reach through, over, under, or around the guard?

A3.1.5. If fixed guarding is not possible because of the nature of an operation, is a properly installed and functioning device used to protect against point-of-operation hazards?

A3.1.6. If a type A gate is used, does it enclose the point of operation before a stroke can be initiated and remain closed as long as the slide is moving?

A3.1.7. If a type B gate is used, does it prevent access prior to the start of the motion or die closure?

A3.1.8. Does the supervisor take special efforts to ensure pull-out devices are used correctly and are properly aligned?

A3.1.9. Are holdout or restraint devices securely anchored and adjusted to prevent the operator from reaching into the point of operation at any time?

A3.1.10. Are presence-sensing devices used only on part-revolution clutch presses?

A3.1.11. Are areas that are not protected by the presence-sensing devices guarded?

A3.1.12. Are sweep-type devices used in conjunction with type safeguarding for point-of-operation guarding?

A3.1.13. Do the buttons on two-hand control devices operate only when the buttons are depressed concurrently? Do the buttons also operate only when depressed continuously (holding time) on the downstroke or else is the clutch disengaged, the brake applied, and the slide stopped?

A3.1.14. Are two-hand trips and presence-sensing devices located far enough away from the point of operation that when operators release the control buttons or disturb the presence-sensing field, they do not have time to reach into the point of operation before the die closes or slide stops?

A3.1.15. When devices such as two-hand controls, presence-sensing devices, type B gate, or movable barriers are used on part-revolution clutch presses, is a control reliability system and brake monitor system used?

A3.1.16. Are energy controls isolated by a lockout device and safety blocks during machine repairs or alterations of the die area?

A3.1.17. Are single or dual hand-lever-operated power presses equipped with a spring latch on the operating lever to prevent premature or accidental tripping?

A3.1.18. Are the operating levers on hand-tripped machinery with more than one operating station interlocked?

A3.1.19. Is a means provided to select **OFF**, **INCH**, **SINGLE STROKE**, or **CONTINUOUS** modes of operation? Is it integrated with the clutch brake control to govern the operation mode of the presses?

A3.1.20. During the **inch** operating mode, is exposure to the worker's hands to the point of operation protected by one of the following:

A3.1.20.1. Concurrent use of both hands to actuate the clutch?

A3.1.20.2. Use of a single control protected against accidental actuation? Is the control located so the worker cannot reach into the point of operation while actuating the control?

A3.1.21. Do two-handed controls for single-stroke press machines ensure safe operation (by design, construction, and (or) separation) so that:

A3.1.21.1. The concurrent use of both hands is required to trip the press?

A3.1.21.2. Machine adjustments can be made, but the concurrent use of both hands is required during the die closing portion of the stroke?

A3.1.21.3. Repetitive operation is not possible unless the controls are activated in proper sequence? Does the control system require that all operators' hand controls are released before an interrupted stroke can be resumed?

A3.1.22. Are individual operator's two-hand trip controls designed and constructed so that the use of both hands is required to protect against unintentional operations? Is a control arrangement used that requires concurrent operation of both the individual operator's hand controls? Is bypass of control interlocks prohibited?

A3.1.23. Do two-hand trip systems on full-revolution-clutch machines provide anti-repeat protection for operators?

A3.1.24. When two-hand trip systems are used on multiple operator machines, does each operator have a separate set of controls?

A3.1.25. Are operators provided picks, pliers, tongs, and other hand-feeding tools required for the safe handling of stock, dies, or materials?

A3.1.26. Are these tools used in addition to the required protective clothing, equipment, or machine guarding?

A3.1.27. Is a die setter's safety bar used for turning the flywheel when the power is off?

A3.1.28. Are individual die guards attached to the die shoe, stripper, or die block in a fixed position as alternates or supplements to other guarding methods? Are they designed so the operator cannot reach over, under, or around the guard into the danger zone?

A3.1.29. Are attachment points provided on dies requiring mechanical handling?

A3.1.30. Are die stops or other means used to prevent inadvertent movement of the die on inclined presses?

A3.2. Hydraulic Press: (paragraph 3.2.2.)

A3.2.1. Are hydraulic power presses safeguarded to prevent the operator's hands entering the area between the dies during press cycling?

A3.2.2. Do controls meet the requirements of paragraphs 3.2.15. and 3.2.16.?

A3.2.3. When two hand control systems are installed, do they incorporate an anti-repeat feature?

A3.2.4. Is the **Stop and Auto Return** switch (when provided) color-coded yellow? Is a power disconnect or **Stop** switch (capable of being locked) provided?

A3.2.5. Are energy sources controlled as referenced in paragraph 2.2.11.?

A3.2.6. Do pneumatic and hydraulic systems meet the requirements of paragraph 3.2.19.?

A3.3. Press Brakes: (paragraph 3.2.3.)

A3.3.1. Do press brake controls meet the requirements of paragraphs 3.2.15. and 3.2.16.?

A3.3.2. Are energy sources controlled as referenced in paragraph 2.2.11.?

A3.3.3. Do pneumatic and hydraulic systems meet the requirements of paragraph 3.2.19.?

A3.3.4. Is the type of safeguard used geared to the operation being performed?

A3.3.5. Does the supervisor ensure that safeguards are available and used?

A3.3.6. Are the following requirements used, based upon the type of safeguard available and installed for the operation:

A3.3.6.1. Paragraph 2.2.12. - *Safeguarding by Distance or Location*?

A3.3.6.2. Paragraph 2.2.13. - *Safeguarding Device*?

A3.3.6.3. Paragraph 3.2.20. - *Related Tools*?

A3.3.6.4. Paragraph 3.2.21. - *Power Transmission Belts and Pulleys*?

A3.3.6.5. Paragraph 3.2.22. - *Power Clamping, Work Holding Equipment*?

A3.4. Shapers, Forming Rolls, Calenders, and Cold Headers: (paragraph 3.2.4.)

A3.4.1. Do controls meet the requirements of paragraphs 3.2.15. and 3.2.16.?

A3.4.2. Are energy sources controlled as referenced in paragraph 2.2.11.?

A3.4.3. Are all pneumatic and hydraulic components designed and maintained to meet paragraph 3.2.19. requirements?

A3.4.4. Is the primary function of the safeguards to protect the operator's hands, fingers, and other body parts from contacting the point of operation and slide mechanisms?

A3.4.5. Are adjustable barrier or enclosure safeguards used to the maximum extent possible?

A3.4.6. Are the requirements of paragraphs 2.2.13. and 2.2.14. used in evaluating the safeguard?

A3.4.7. Are additional barrier guards provided at the refuse drop areas?

A3.4.8. Is the rear of the reciprocating ram guarded to protect other employees?

A3.4.9. Is a chip guard provided to prevent flying chips from striking the operator or other workers?

A3.4.10. Are all materials securely clamped in position on the machine table?

A3.5. Shears: (paragraph 3.2.5.)

A3.5.1. Is safeguarding provided to protect the operators from the hazardous areas?

A3.5.2. Do controls meet the requirements of paragraphs 3.2.15. and 3.2.16.?

A3.5.3. Are energy sources controlled as referenced in paragraph 2.2.11.?

A3.5.4. Do pneumatic and hydraulic systems meet the standards of paragraph 3.2.19.?

A3.5.5. Is barrier or enclosure guarding considered the primary means of safeguarding shearing machines?

A3.5.6. Are paragraphs 2.2.13., 2.2.14., and 3.2.20. through 3.2.22. used to evaluate the adequacy of installed guards or devices?

A3.5.7. Is the area where sheared or punched refuse drops barricaded to prevent injuries to operators and helpers?

A3.5.8. Are machines equipped with an emergency stop control?

A3.6. Lathes, Screw/Bar, and Chucking Machines: (paragraph 3.2.6.)

A3.6.1. Do controls meet the requirements of paragraphs 3.2.15. and 3.2.16.?

A3.6.2. Are energy sources controlled as referenced in paragraph 2.2.11.?

A3.6.3. Do pneumatic and hydraulic systems (when installed) meet the standards in paragraph 3.2.19.?

A3.6.4. Is a fixed or movable barrier device or awareness device installed when a lathe operates in the automatic or semi-automatic mode?

A3.6.5. Is a barrier guard, rigid awareness barrier (protective railing), or awareness device installed during machine operation on power-indexed turrets that contain an exceptionally long tool or tool-holding device that extends in the operator's workspace?

A3.6.6. Is one of the above safeguards installed when a rotating workpiece extends beyond the normal confines of the machine?

A3.6.7. Is a spindle braking device installed on lathes procured after the date of this standard (if the operator must stop the spindle to manually unload a workpiece)?

A3.6.8. Are chucks always started on the lathe spindle by hand?

A3.6.9. Is the tail stock end of the work countersunk deeply enough so there is minimal chance of the work being torn loose?

A3.6.10. Are tools adjusted in the tool rest so they are slightly above the center?

A3.6.11. When chips are being generated, is a tool, puller, brush, or shovel used to remove them?

A3.6.12. Do operators know they are not to brake the lathe by grasping the chuck, work, or any other machine component?

A3.7. Drilling, Milling, and Boring Machines: (paragraph 3.2.7.)

A3.7.1. Is a barrier guard or guarding device installed and used when:

A3.7.1.1. Machines are operated in an automatic or semi-automatic mode?

A3.7.1.2. Cutting devices are exposed?

A3.7.1.3. Any part of the operator's body is within 1 foot of the cutting device?

A3.7.2. Are awareness barriers used only in situations when a guard or guarding devices would (of itself) present a hazard?

A3.7.3. Does the type of guarding depend on the machine, location, and operation?

A3.7.4. Do the requirements identified in paragraph 3.2.20. apply to the design and installation of shields?

A3.7.5. Are operators cautioned not to hand-hold stock?

A3.7.6. Is a hold-down fixture or stock vise used to prevent injuries?

A3.7.7. Are only drill chucks without protruding set screws used?

A3.7.8. Are auxiliary devices and extra tools stored properly?

A3.7.9. Are drill presses operated only at speeds specified by the press or drill manufacturer for the particular material to be drilled?

A3.7.10. Are automatic and high production drilling machines equipped with barricades or enclosures to separate operators and other personnel from drilling operations?

A3.7.11. Are steps or stairs (when necessary for making adjustments to the machine or work) well constructed, provided with nonslip treads, and in good repair?

A3.7.12. Do controls meet the requirements of paragraphs 3.2.15. and 3.2.16.?

A3.7.13. Are energy sources controlled as referenced in paragraph 2.2.11.?

A3.7.14. Do pneumatic and hydraulic systems (when provided) conform to paragraph 3.2.19.?

A3.8. Planers: (paragraph 3.2.8.)

A3.8.1. Is the reciprocating work and table barricaded, or enclosed, to prevent personnel from being struck by material?

A3.8.2. Is a chip shield provided to prevent chips from flying and striking personnel?

A3.8.3. Are safety dogs placed at each end of the planer table?

A3.8.4. Is material securely clamped in position on the planer table?

A3.9. Saws: (paragraph 3.2.9.)

A3.9.1. Do saws meet the general requirements in paragraphs 3.2.14. through 3.2.19.?

A3.9.2. Do the supervisor and installation ground safety personnel develop requirements on machine safe-guards for saws not covered in this standard?

A3.10. Bandsaws: (paragraph 3.2.10.)

A3.10.1. Are both upper and lower wheels completely enclosed on both sides? Can the enclosures be easily removed for maintenance?

A3.10.2. Is the working part of a saw blade guarded to prevent accidental contact with the saw blade? Is the guard self-adjusting and attached to the gauge so that the guard will completely cover the portion of the saw blade between the guide rolls and the upper wheel enclosure?

A3.10.3. Are saws equipped with an automatic tension control to ensure proper tension of the saw blade?

A3.10.4. Are feed rolls on self-fed bandsaws guarded?

A3.10.5. Is the saw speed kept within the limits recommended by the manufacturer?

A3.11. Hacksaws: (paragraph 3.2.11.)

A3.11.1. Is loss of coolant and lubricants minimized by proper maintenance of the coolant system and the installation of splash shields?

A3.11.2. Are vises, fixtures, and other work-holding equipment used to hold the workpiece securely?

A3.11.3. Does the operator know not to hand-hold stock that is being cut by a power hacksaw?

A3.12. Circular Metal Saws: (paragraph 3.2.12.)

A3.12.1. Does the safeguard have enough strength to protect the operator from a broken saw blade or teeth?

A3.12.2. Does the safeguard enclose the spindle end and nut?

A3.12.3. Is the safeguard provided with an opening or means of removing chips that, in itself, will not create a hazard to the operator?

A3.12.4. Does the safeguard enclose all unused portions of the exposed saw blade? Does a barrier protect the part of the blade used for cutting? Is the barrier positioned to protect the operator from exposure to the blade?

A3.12.5. Is the loss of coolant and lubricants minimized by proper maintenance of the coolant system and the installation of splash shields?

A3.12.6. Are vises, fixtures, and other work-holding equipment used to hold the workpiece securely?

A3.12.7. Are all circular sawing machines equipped with a pair of flanges?

A3.13. Cut-Off and Contour Saws: (paragraph 3.2.13.)

A3.13.1. Are both the upper and lower wheels on both sides of saws enclosed? Is the enclosure hinged to permit easy access to the saw blade?

A3.13.2. Is the working part of the saw blade guarded to prevent accidental contact with the saw blade? Is the guard self-adjusting and is it attached to the gauge so the guard will completely cover the portion of the saw blade between the guide rolls and the upper wheel enclosure?

A3.13.3. Are abrasive cut-off saws connected to an exhaust system?

A3.13.4. Do operators know not to hand-hold stock being cut by a power hacksaw?

A3.14. Riveting Machines (paragraph 3.2.14.). Is a guard provided to prevent the operators from placing their hands between dies?

A3.15. Operator Controls: (paragraph 3.2.15.)

A3.15.1. Are controls within easy reach of the machine operator? Are they placed so the worker does not have to reach past moving parts?

A3.15.2. Are controls positioned or protected against accidental or inadvertent operation?

A3.15.3. Do operators know not to wedge controls for continuous operation?

A3.15.4. Are controls clearly identified when their function is not self-evident? Do they not initiate motion unrelated to its designation?

A3.15.5. If job circuits are used, are they designed to prevent continuous run or automatic operation?

A3.15.6. Are foot (treadle) controls protected against unexpected and accidental tripping? Do these controls have a nonslip surface?

A3.15.7. Are energy sources controlled as referenced in paragraph 2.2.11.?

A3.16. Mechanical Controls: (paragraph 3.2.16.)

A3.16.1. Do handwheels turned in a clockwise rotation produce a linear movement to the right, away, or upward? If a rotary motion is produced by the handwheel, does clockwise rotation cause clockwise movement of the controlled component?

A3.16.2. Do control levers move in the same direction as the controlled component when both motions are parallel?

A3.16.3. Is an adjustable barrier guard installed when crank and handwheel controls with protrusions rotate at more than 50 surface feet per minute?

A3.17. Multiple Control Stations: (paragraph 3.2.17.)

A3.17.1. When a setup control station is provided, does selection of the setup station render the operator's station inoperative, except for emergency stop?

A3.17.2. Does switching from one control station not create a hazard?

A3.17.3. When more than one operator is required to operate the machine from different control stations, is each station provided with a cycle start button (which must be depressed concurrently in order to initiate the cycle)?

A3.17.4. Are all cycle start buttons other than the one being used made inoperative (when one operator can operate the machine from more than one station)?

A3.17.5. Where parts are manually loaded and the operator may be exposed to a hazard due to cutter or machine table movements, is the rapid traverse from one part or position to the other initiated by the operator?

A3.18. Emergency Stop Control: (paragraph 3.2.18.)

A3.18.1. Do all machines incorporate one or more emergency stop controls that, upon momentary operation, de-energize all machine motions?

A3.18.2. Are these emergency stops located at each operator control station? If inherent hazards are present at other operating position, is an emergency stop provided?

A3.18.3. Is the emergency stop color coded red?

A3.18.4. Does the emergency stop control override all other controls? When actuated, does it not create other hazards?

A3.18.5. Can machine motions that are stopped by the emergency or master switch only be restarted by deliberate action by the operator?

A3.19. Pneumatic and Hydraulic Systems: (paragraph 3.2.19.)

A3.19.1. Are circuits designed and components selected, applied, and adjusted so loss of control media will not cause a hazard?

A3.19.2. Are circuits designed and components applied so pressure variations do not cause a hazard?

A3.19.3. Are components used that cannot be adjusted outside the safe working range of the circuit?

A3.19.4. Are means provided to prevent operation when loss of working pressure can cause a hazard?

A3.19.5. Do circuits employing accumulator tanks automatically vent the accumulator pressure or isolate the accumulator when the machine is shut off?

A3.19.6. Are nonvented accumulators identified with a sign saying **"WARNING - PRESSURIZED VESSEL"** or the nearest commercially available equivalent?

A3.19.7. Is charging and discharging information for proper servicing given on or near the accumulator (in a visible location) and in the maintenance manual?

A3.19.8. Are gas-charged accumulators operating above 200 psig charging pressure charged with inert gas?

A3.19.9. Are flexible hoses arranged so they do not create a tripping hazard?

A3.19.10. If failed flexible hoses may constitute a whipping hazard, are they restrained or contained?

A3.19.11. Whenever pressure is maintained after power is off, is a warning plate used?

A3.19.12. Are procedures for depressurizing the circuit noted in the maintenance manual?

A3.20. Related Equipment: (paragraph 3.2.20.)

A3.20.1. Are shields used to provide protection from flying particles?

A3.20.2. Is a splash shield installed when chips or coolant fluids are splashed on the operator or on the work area and passageway floor?

A3.20.3. Are holding tools used when it would otherwise be necessary to place hands in the danger zone? Are these tools used in addition to guards?

A3.21. Power Transmission Belts and Pulleys: (paragraph 3.2.21.)

A3.21.1. Are horizontal belts and ropes above floors or platforms guarded for their entire length if:

A3.21.1.1. Located over passageways or workplaces;

A3.21.1.2. Center-to-center distance between pulleys is 10 feet or more; or

A3.21.1.3. The belt is 8 inches or more in width?

A3.21.2. Are vertical belts running over a lower pulley above the floor or platform guarded at the bottom in the same manner as overhead belts?

A3.21.3. Where loose pulleys or idlers are not practical, are belt perches used to keep idler belts away from the shafts? Are the perches made of strong materials and designed for the safe shifting of belts?

A3.21.4. Do operators know that belt dressing should not be applied when the belt or rope is in motion? If it is necessary, is dressing applied where belts leave the pulleys, not where they approach them?

A3.21.5. Is a guard provided to prevent the belt from leaving the pulley on the side where insufficient clearance exists (with exceptions)?

A3.21.6. Where there are overhanging pulleys on a line, jack, or countershaft (with no bearing between the pulley and the outer end of the shaft) is a guard installed to prevent the belt from running off the pulley?

A3.21.7. Are pulleys with cracks or pieces broken out of rims taken out of service?

A3.21.8. Are pulleys (used in areas where they would be exposed to corrosion) made of corrosion-resistant material? Are they inspected semiannually to ensure they are in satisfactory condition?

A3.22. Powered Clamping, Work Holding Devices: (paragraph 3.2.22.)

A3.22.1. Are these devices provided with a safeguard to warn the operator or contain the workpiece when there is a lack of clamping pressure?

A3.22.2. If an electrical interlock is installed does it shut off power to the lathe when hydraulic pressure drops or electrical interruption occurs?

A3.22.3. If an audible or visual warning device is used, is it visible or audible to the operator at his normal work position?

Attachment 4

PERMANENTLY INSTALLED GRINDING MACHINES CHECKLIST

This is not an all-inclusive checklist. It simply highlights some critical items in this chapter. Other requirements exist in the chapter that are not included in the checklist. Where approariate, MAJCOMs, FOAs, DRUs, local safety offices, and supervisors will add to this checklist to include command or individual shop-unique requirements or situations.

A4.1. Exhaust Ventilation (paragraph 4.2.1.). Are local exhaust ventilation systems provided and used whenever dry grinding, polishing, or buffing is performed to maintain employee exposures within permissible exposure limits?

A4.2. Wheel and Spindle Speeds: (paragraph 4.2.2.)

A4.2.1. Is the spindle rpm of the grinders shown on the machine and in a location that is readily visible to the operator?

A4.2.2. Are grinding wheels that do not have the operating speed affixed to the wheel, tagged and removed from service until the rpm rating is validated?

A4.3. Safe Operating Procedures: (paragraph 4.2.3.)

A4.3.1. Are abrasive wheel machines only operated with safety guards installed?

A4.3.2. Are peripheral protectors (tongue guards) positioned so that there is no more than one-fourth of an inch opening between the wheel and the guard?

A4.3.3. Are work rests always used during all off-hand grinding operations?

A4.3.4. Are work rests rigidly constructed?

A4.3.5. Are work rests designed so that they may be adjusted to compensate for wheel wear?

A4.3.6. Are work rests adjusted closely to the wheel with a maximum opening of one-eighth of an inch to prevent the work from being jammed between the wheel and the rest?

A4.3.7. Are work rests securely clamped after each adjustment?

A4.3.8. Are adjustments made only with the wheel out of motion?

A4.3.9. Are precautions taken to prevent grinding of stock that is thin enough to be pulled between work rests and the wheel?

A4.3.10. Are the abrasive wheel machines only operated within rated speeds?

A4.3.11. Are grinding wheels removed from service when any of the following occurs:

A4.3.11.1. Cracked, defective, or out-of-balance?

A4.3.11.2. When worn to a size that would allow the flange assembly to contact the piece being ground on the work rest?

A4.3.12. Do operators of grinding machines stand to one side when initially turning the machine on, until it has reached its operating speed?

A4.3.13. When the machine chatters or vibrates, do operators stop the machine and inspect it to determine the cause?

A4.3.14. Are all operators prevented from using the abrasive grinding wheels to grind aluminum, brass, copper, or other soft metals (unless the wheel is specifically designed for that purpose)?

A4.3.15. Are operators prevented from using the side of the wheel for grinding (other than wheels designed for that purpose)?

A4.3.16. Do all operators ensure that the grinders, buffers and wire brush machines are turned off when work is completed or prior to leaving the vicinity of the machine?

A4.3.17. Are operators who wear loose-fitting clothing prevented from using these machines?

A4.3.18. During any grinding operation, do the operators wear safety glasses or goggles for protection of the eyes, in conjunction with a face shield for protection from wheel breakage, sparks, and other grinding debris?

A4.3.19. Do operators wear shop aprons of heavy construction when grinding operations are performed on a continuing or prolonged basis?

A4.3.20. Do operators wear gloves when the work has burrs, rough edges or presents other hazards to their hands?

A4.3.21. Do wire brush wheel operators utilize protective shop aprons of heavy construction and a face shield during all operations?

A4.3.22. Do polishing and buffer wheel operators wear a face shield during all operations?

A4.4. Inspections (paragraph 4.2.4.). Do operators inspect the grinding machines prior to each usage for the following:

A4.4.1. Work rests for security and proper adjustment (e.g., one-eighth of an inch maximum)?

A4.4.2. Wheels for security and condition (e.g., cracks, gouges, chipped edges, or uneven wear)?

A4.4.3. Wheels for evidence of side grinding, or grinding of soft metals on wheels not designed for these purposes?

A4.4.4. Shatter-resistant transparent shields for cleanliness, scoring and proper placement?

A4.4.5. Machine guards and power transmission guards for condition, security, and proper alignment?

A4.4.6. Periphery (tongue) guards for security and proper adjustment (e.g., one-fourth of an inch maximum opening)?

A4.4.7. Proper lighting at point of operation?

A4.5. Maintenance and Lubrication: (paragraph 4.2.5.)

A4.5.1. Prior to performing maintenance on grinding equipment do operators ascertain that the machine power source is turned off and locked out or the power cord is unplugged?

A4.5.2. Do maintenance personnel refer to and follow the manufacturer’s recommendation concerning size and design of mounting flanges and mounting techniques prior to any maintenance?

A4.5.3. Before the wheel is mounted, is the spindle speed of the machine checked to ensure that it does not exceed the maximum operating speed marked on the wheels?

A4.5.4. Is the shelf life of the wheels checked to ensure that the requirements have not been exceeded?

A4.5.5. Have all the wheels received a thorough visual inspection and received a ring test prior to use?

A4.5.6. Does the grinding wheel fit freely on the spindle and remain free under all grinding conditions?

A4.5.7. Are all contact surfaces of wheels, blotters, and flanges flat and free of foreign matter?

A4.5.8. If a bushing is used in the wheel hole, is the width of the bushing less than the width of the wheel so that it does not contact the flange?

A4.5.9. Are abrasive wheels mounted between flanges that are not less than one-third the diameter of the wheel?

A4.5.10. Are flanges free of rough surfaces or sharp edges?

A4.5.11. Are flanges dimensionally accurate and in good balance?

A4.5.12. Are both flanges of the same diameter and have equal bearing surface?

A4.5.13. Is the driving flange securely fastened to the spindle and does the bearing surface run true?

A4.5.14. Where more than one wheel is mounted between a single set of flanges, are the wheels cemented together or separated by specially designed spacers?

A4.5.15. Are the spacers equal in diameter to the mounting flanges and have equal bearing surfaces?

A4.5.16. Are blotters prohibited from being used as spacers?

A4.5.17. When wheels are to be cemented together, are the wheel manufacturer’s recommendations followed?

A4.5.18. When the bearing surfaces become worn, warped, sprung, or damaged are they trued and resurfaced?

A4.5.19. When resurfacing or truing bearing surfaces, is the removal of material prohibited beyond the point that it loses its rigidity?

A4.5.20. Are blotters always used between flanges and abrasive wheel surfaces to ensure uniform distribution of flange pressure?

A4.5.21. When blotters are required, do they cover the entire contact area of wheel flanges per manufacturer’s recommendations?

A4.5.22. Are the safety guards in place prior to starting the machine?

A4.5.22.1. After the guards are reinstalled, is the wheel rotated several revolutions by hand to insure that it clears both the work rest and the safety guards prior to starting?

A4.5.22.2. Are newly installed wheels run at full operating speed for at least one minute before work is applied?

A4.5.22.3. During the one minute run-in of the wheel are the operator and other personnel standing clear of the machine?

A4.5.23. When performing wheel dressing operations, are wheel dressing tools properly equipped with hood guards over the tops of cutters?

A4.5.24. Is the dresser supported on the work rest and the work rest adjusted away from the wheel so that the heel of the dresser hooks over the work rest? Does the work rest guide the dresser as it moves back and forth across the wheel face?

A4.5.25. Is dressing accomplished only by personnel trained in this task?

A4.5.26. Do personnel wear face shields over safety glasses for face protection, and a respirator if conditions warrant?

A4.5.27. Do personnel utilize a dressing tool designed for the task?

A4.5.28. Do personnel inspect star dressers for loose shaft and worn discs prior to use?

A4.5.29. Do personnel round off wheel edges with a handstone before and after dressing to prevent the edges from chipping?

A4.5.30. Do personnel use work rests to support and guide the tool and use a tool holder if one is available?

A4.5.31. Do personnel apply moderate pressure, slowly and evenly?

A4.5.32. Do personnel always apply diamond dressers at the center or slightly below the center of the wheel?

A4.5.33. Do personnel establish and utilize lubrication intervals for the grinding machine spindle bearings based on the manufacturer's recommendations?

A4.6. Guarding: (paragraph 4.2.6.)

A4.6.1. Are guards used on all grinding machines, except wheels used for internal work where the work offers protection?

A4.6.2. On wheels requiring guards, does the guard cover the spindle end, nut, and the flange projections?

A4.6.3. Is the guard mounted so as to maintain proper alignment with the wheel?

A4.6.4. Do the fasteners used to mount the guard equal or exceed the strength of the guard?

A4.6.5. Does the angular exposure of the grinding wheel periphery and sides for safety guards not exceed 90 degrees or one-fourth of the periphery? Is the angular exposure of the grinding wheel periphery and sides for safety guards used on bench and floor (pedestal) grinders less than the maximum 90 degrees or less than one-fourth of the periphery?

A4.6.6. When the operator stands in front of the opening of bench and floor stand (pedestal) grinder, is the unit equipped with a peripheral protector (tongue guard) that can be adjusted to the decreasing diameter of the wheel? Is the opening maintained at one-fourth of an inch or less?

A4.6.7. Is the angular exposure of the cylindrical grinding wheel periphery and sides for safety guards maintained at less than 180 degrees?

A4.6.8. When the operator stands in front of the opening of the cylindrical grinder, is the unit equipped with a peripheral protector (tongue guard) that can be adjusted to the decreasing diameter of the wheel? Is the opening maintained at one-fourth of an inch or less?

A4.6.9. Where the work is applied to the wheel above the horizontal center line, is the exposure of the grinding wheel periphery as small as possible and does not exceed 60 degrees?

A4.7. Wet Grinding (paragraph 4.2.7.). Do wet grinding machines meet the same criteria for guarding, work rest, and machine set up as required for other abrasive wheel machinery? Do they include the following requirements:

A4.7.1. When shutting down a wet grinding operation, do personnel shut off the coolant first and allow the wheel to rotate until the coolant has been spun out?

A4.7.2. Are wet process grinding wheels restricted from being left partially submerged in water, preventing a possible unbalanced wheel that may break when rotated?

A4.7.3. Do operators follow the manufacturer's directions to prevent coolant alkalinity from affecting organic bonded wheels?

A4.7.4. Are controls established to reduce slipping hazards on floor surfaces around wet processes, i.e., rough concrete or have non-skid materials or mats applied?

A4.8. Wheel Storage (paragraph 4.2.8.). Are abrasive wheels handled and stored as follows to prevent damage:

A4.8.1. Are wheels stored only in dry areas that are not subject to extreme temperature changes, or below freezing temperatures?

A4.8.2. Are wheels taken from a cold storage room permitted to warm up to room temperature before work is applied to it?

A4.8.3. Is storage arranged to allow wheel selection and removal without damaging other wheels?

A4.8.4. Are thin organic bonded cutting wheels only stored on a flat horizontal surface away from heat?

A4.8.5. Are straight or tapered wheels only stored supported on edges in racks?

A4.8.6. Are wheels dated when placed in storage so they can be issued oldest first?

A4.8.7. Are heavy wheels moved by hand trucks or powered trucks, and not rolled on the floor?

A4.8.8. Are wheel storage areas as close to the grinding operations as practical?

A4.8.9. Are wheels that are found unsatisfactory, tagged and discarded unless repairs can be performed?

A4.9. Polishing and Buffing Wheels: (paragraph 4.2.9.)

A4.9.1. When polishing and buffing wheels are driven by variable speed motors, are speed controls safeguarded to prevent accidental change?

A4.9.2. When rouge or tripoli is applied to a rotating polishing or buffing wheel, is the side of the cake held lightly against the wheel's periphery? If a stick is used, is the side of the stick applied so it will fly away from the wheel?

A4.10. Special Grinding Operations (paragraph 4.2.10.). Do supervisors of operations that use materials such as magnesium, titanium, thorium, and beryllium contact installation ground safety, fire department, and bioenvironmental engineering personnel for assistance to determine safe work practices and protective equipment needs?